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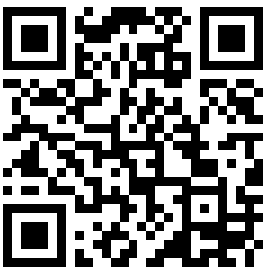

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Bureau of Natural Gas

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DRAFT ENVIRONMENTAL IMPACT STATEMENT

FOR THE CONSTRUCTION AND OPERATION OF AN LNG IMPORT TERMINAL AT EVERETT, MASSACHUSETTS

DOCKET NOS:

CP 73-135-DISTRIGAS OF MASSACHUSETTS CORPORATION
CP 73-137-DISTRIGAS OF MASSACHUSETTS CORPORATION
CP 74-227-DISTRIGAS CORPORATION
CP 76-9-DISTRIGAS CORPORATION

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February 1976

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FEDERAL POWER COMMISSION
BUREAU OF NATURAL GAS

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DRAFT ENVIRONMENTAL IMPACT STATEMENT FOR THE CONSTRUCTION AND OPERATION OF AN LNG IMPORT TERMINAL AT EVERETT, MASSACHUSETTS

Docket Nos. CP73-135 - Distrigas of Massachusetts Corporation
CP74-137 - Distrigas of Massachusetts Corporation
CP74-227 - Distrigas Corporation
CP76-9 - Distrigas Corporation

February 1976

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FOREWORD

The Federal Power Commission, pursuant to the Natural Gas Act, is authorized to issue certificates of public convenience and necessity for the construction and operation of natural gas facilities subject to its jurisdiction, on the conditions that:

> /a/ certificate shall be issued to any qualified applicant therefor, authorizing the whole or any part of the operation, sale, service, construction, extension, or acquisition covered by the application, if it is found that the applicant is able and willing properly to do the acts and to perform the service proposed and to conform to the provisions of the Act and the requirements, rules, and regulations of the Commission thereunder, and that the proposed service, sale, operation, construction, extension, or acquisition, to the extent authorized by the certificate, is or will be required by the present or future public convenience and necessity; otherwise such application shall be denied.

15 U.S.C. 717

The Commission shall have the power to attach to the issuance of the certificate and to the exercise of the rights granted thereunder such reasonable terms and conditions as the public convenience and necessity may require.

Section 1.6 of the Commission's Rules of Practice and Procedure allows any person alleging applicant's non-compliance with such conditions to file a complaint noting the basis for such objection for the Commission's consideration. 18 C.F.R. §1.6 (1972).

Section 2.82(c) of the Commission's General Rules allows any person to file a petition to intervene on the basis of the staff draft environmental impact statement.

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FEDERAL POWER COMMISSION-ORDER 415-C
(Issued December 18, 1972)
STATEMENT OF GENERAL POLICY TO IMPLEMENT PROCEDURES FOR COMPLIANCE WITH THE NATIONAL ENVIRONMENTAL POLICY ACT OF 1969

§ 2.80 Detailed Environmental Statement.

(a) It shall be the general policy of the Federal Power Commission to adopt and to adhere to the objectives and aims of the National Environmental Policy Act of 1969 (Act) in its regulation under the Federal Power Act and the Natural Gas Act. The National Environmental Policy Act of 1969 requires, among other things, all Federal agencies to include a detailed environmental statement in every recommendation or report on proposals for legislation and other major Federal actions significantly affecting the quality of the human environment.

(b) Therefore, in compliance with the National Environmental Policy Act of 1969 the Commission staff shall make a detailed environmental statement when the regulatory action taken by us under the Federal Power Act and Natural Gas Act will have a significant environmental impact. A "detailed statement" prepared in compliance with the requirements of §§ 2.81 through 2.82 of this Part shall fully develop the five factors listed hereinafter in the context of such considerations as the proposed activity's direct and indirect effect on the air and water environment of the project or natural gas pipeline facility; on the land, air, and water biota; on established park and recreational areas; and on sites of natural, historic, and scenic values and resources of the area. The statement shall discuss the extent of the conformity of the proposed activity with all applicable environmental standards. The statement shall also fully deal with alternative courses of action to the proposal and, to the maximum extent practicable, the environmental effects of each alternative. Further, it shall specifically discuss plans for future development related to the application under consideration.

The above factors are listed to merely illustrate the kinds of values that must be considered in the statement. In no respect is this listing to be construed as covering all relevant factors.

The five factors which must be specifically discussed in the detailed statement are:

(1) the environmental impact of the proposed action,
(2) any adverse environmental effects which cannot be avoided should the proposal be implemented;
(3) alternatives to the proposed action,
(4) the relationship between local short-term uses of man's environment and the maintenance and enhancement of long-term productivity, and
(5) any irreversible and irretrievable commitments of resources which would be involved in the proposed action should it be implemented.

(c) (i) To the maximum extent practicable no final administrative action is to be taken sooner than ninety days after a draft environmental statement has been circulated for comment or thirty days after the final text of an environmental statement has been made available to the Council on Environmental Quality and the public.

(c) (ii) Upon a finding that it is necessary and appropriate in the public interest, the Commission may dispense with any time period specified in §§ 2.80-2.82.

§ 2.81 Compliance with the National Environmental Policy Act of 1969 under Part I of the Federal Power Act

(a) All applications for major projects (those in excess of 2,000 horsepower) or for reservoirs only providing regulatory flows to downstream (major) hydroelectric projects under Part I of the Federal Power Act for license or relicense, shall be accompanied by Exhibit W, the applicant's detailed report of the environmental factors specified in § 2.80 and 4.41. All applications for surrender or amendment of a license proposing construction, or operating change of a project shall be accompanied by the applicant's detailed report of the environmental factors specified in § 2.80. Notice of all such applications shall continue to be made as prescribed by law.

(b) The staff shall make an initial review of the applicant's report and, if necessary, require applicant to correct deficiencies in the report. If the proposed action is determined to be a major Federal action significantly affecting the quality of the human environment, the staff shall conduct a detailed independent analysis of the action and prepare a draft environmental impact statement which shall be made available to the Council on Environmental Quality, the Environmental Protection Agency, other appropriate governmental bodies, and to the public, for comment. The statement shall also be served on all parties to the proceeding. The Secretary of the Federal Power Commission shall cause prompt publication in the Federal Register of notice of the availability of the staff's draft environmental statement. Written comments shall be made within 45 days of the date the notice of availability appears in the Federal Register. If any governmental entity, Federal, state, or local, or any member of the public, fails to comment within the time provided, it shall be assumed, absent a request for a specific extension of time, that such entity or person has no comment to make. Extensions of time shall be granted only for good cause shown. All entities filing comments with the Commission will submit ten copies of such comments to the Council on Environmental Quality. Upon expiration of the time for comment the staff shall consider all comments received and revise as necessary and finalize its environmental impact statement which, together with the comments received, shall accompany the proposal through the agency review and decision-making process and shall be made available to the parties to the proceeding, the Council on Environmental Quality, and the public. In the event the proposal is the subject of a hearing the staff's environmental statement will be placed in evidence at that hearing.

(c) Any person may file a petition to intervene on the basis of the staff draft environmental statement. All interveners taking a position on environmental matters shall file timely comments, in accordance with paragraph (b) of this section, on the draft statement with the Commission including, but not limited to, an analysis of their environmental position in the context of the factors enumerated in 2.80, and specifying any differences with staff's position upon which intervener wishes to be heard. Nothing herein shall preclude an intervener from filing a detailed environmental impact statement.

(d) In the case of each contested application, the applicant, staff, and all interveners taking a position on environmental matters shall offer evidence for the record in support of their environmental position. The applicant and all such interveners shall specify any differences with the staff's position, and shall include, among other relevant factors, a discussion of their position in the context of the factors enumerated in §2.80.

(e) In the case of each contested application, the initial and reply briefs filed by the applicant, the staff and all interveners taking a position on environmental matters must specifically analyze and evaluate the evidence in the light of the environmental criteria enumerated in § 2.80. Furthermore, the Initial Decision of the Presiding Administrative Law Judge in such cases, and the final order of the Commission dealing with the application on the merits in all cases, shall include an evaluation of the environmental factors enumerated in § 2.80 and the views and comments expressed in conjunction therewith by the applicant and all those making formal comment pursuant to the provisions of this section.

§ 2.82 Compliance with the National Environmental Policy Act of 1969 Under the Natural Gas Act.

(a) All certificate applications filed under Section 7(c) of the Natural Gas Act (15 U.S.C. 717f(c)) for the construction of pipeline facilities, except abbreviated applications filed pursuant to Sections 157.7(b), (c) and (d) of Commission Regulations and producer applications for the sale of gas filed pursuant to Sections 157.22-29 of Commission Regulations, shall be accompanied by the applicant's detailed report of the environmental factors specified in § 2.80. Notice of all such applications shall continue to be made as prescribed by law.

(b) The staff shall make an initial review of the applicant's report and, if necessary, require applicant to correct deficiencies in the report. If the proposed action is determined to be a major Federal action significantly affecting

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the quality of the human environment, the staff shall conduct a detailed independent analysis of the action and prepare a draft environmental impact statement which shall be made available to the Council on Environmental Quality, the Environmental Protection Agency, other appropriate governmental bodies, and to the public, for comment. The statement shall also be served on all parties to the proceeding. The Secretary of the Federal Power Commission shall cause prompt publication in the Federal Register of notice of the availability of the staff's draft environmental statement. Written comments shall be made within 45 days of the date the notice of availability appears in the Federal Register. If any governmental entity, Federal, state, or local, or any member of the public, fails to comment within the time provided, it shall be assumed, absent a request for a specific extension of time, that such entity or person has no comment to make. Extensions of time shall be granted only for good cause shown. All entities filing comments with the Commission shall submit ten copies of such comments to the Council on Environmental Quality. Upon expiration of the time for comment the staff shall consider all comments received and revise as necessary and finalize its environmental impact statement which, together with the comments received, shall accompany the proposal through the agency review and decision-making process and shall be made available to the parties to the proceeding, the Council on Environmental Quality, and the public. In the event the proposal is the subject of a hearing, the staff's environmental statement will be placed in evidence at that hearing.

(c) Any person may file a petition to intervene on the basis of the staff draft environmental statement. All interveners taking a position on environmental matters shall file timely comments, in accordance with paragraph (b) of this section, on the draft statement with the Commission including, but not limited to, an analysis of their environmental position in the context of the factors enumerated in § 2.80, and specifying any differences with staff's position upon which intervener wishes to be heard. Nothing herein shall preclude an intervener from filing a detailed environmental impact statement.

(d) In the case of each contested application, the applicant staff, and all interveners taking a position on environmental matters shall offer evidence for the record in support of their environmental position. The applicant and all such interveners shall specify any differences with the staff's position, and shall include, among other relevant factors, a discussion of their position in the context of the factors enumerated in §2.80.

(e) In the case of each contested application, the initial and reply briefs filed by the applicant, the staff, and all interveners taking a position on environmental matters must specifically analyze and evaluate the evidence in the light of the environmental criteria enumerated in § 2.80. Furthermore, the Initial Decision of the Presiding Administrative Law Judge in such cases, and the final order of the Commission dealing with the application on the merits in all cases, shall include an evaluation of the environmental factors enumerated in § 2.80 and the views and comments expressed in conjunction therewith by the applicant and all those making formal comment pursuant to the provisions of this section.

FEDERAL POWER COMMISSION
RULES OF PRACTICE AND PROCEDURE
18 CFR 1.8 Intervention

"(a) Initiation of intervention. Participation in a proceeding as an intervener may be initiated as follows:

(1) By the filing of a notice of intervention by a State Commission, including any regulatory body of the State or municipality having jurisdiction to regulate rates and charges for the sale of electric energy, or natural gas, as the case may be, to consumers within the intervening State or municipality.

(2) By order of the Commission upon petition to intervene.

(b) Who may petition. A petition to intervene may be filed by any person claiming a right to intervene or an interest of such nature that intervention is necessary or appropriate to the administration of the statute under which the proceeding is brought. Such right or interest may be:

(1) A right conferred by statute of the United States;

(2) An interest which may be directly affected and which is not adequately represented by existing parties and as to which petitioners may be bound by the Commission's action in the proceeding (the following may have such an interest; consumers served by the applicant, defendant, or respondent; holders of securities of the applicant, defendant, or respondent; and competitors of the applicant, defendant, or respondent).

(3) Any other interest of such nature that petitioner's participation may be in the public interest.

(c) Form and contents of petitions. Petitions to intervene shall set out clearly and concisely the facts from which the nature of the petitioner's alleged right or interest can be determined, the grounds of the proposed intervention, and the position of the petitioner in the proceeding, so as fully and completely to advise the parties and the Commission as to the specific issues of fact or law to be raised or controverted, by admitting, denying or otherwise answering specifically and in detail, each material allegation of fact or law asserted in the proceeding, and citing by appropriate reference the statutory provisions or other authority relied on: Provided, that where the purpose of the proposed intervention is to obtain an allocation of natural gas for sale and distribution by a person or municipality engaged or legally authorized to engage in the local distribution of natural or artificial gas to the public, the petition shall comply with the requirements of Part 156 of this chapter (i.e., Regulations Under the Natural Gas Act). Such petitions shall in other respects comply with the requirements of §§ 1.15 to 1.17, inclusive.

(d) Filing and service of petitions. Petitions to intervene and notices of intervention may be filed at any time following the filing of a notice of rate or tariff change, or of an application, petition, complaint, or other document seeking Commission action, but in no event later than the date fixed for the filing of petitions to intervene in any order or notice with respect to the proceedings issued by the Commission or its Secretary, unless, in extraordinary circumstances for good cause shown, the Commission authorizes a late filing. Service shall be made as provided in §1.17. Where a person has been permitted to intervene notwithstanding his failure to file his petition within the time prescribed in this paragraph, the Commission or officer designated to preside may where the circumstances warrant, permit the waiver of the requirements of §1.26(c)(5) with respect to copies of exhibits for such intervener.

(e) Answers to petitions. Any party to the proceeding or staff counsel may file an answer to a petition to intervene, and in default thereof, may be deemed to have waived any objection to the granting of such petition. If made, answers shall be filed within 10 days after the date of service of the petition, but not later than 5 days prior to the date set for the commencement of the hearing, if any, unless for cause the Commission with or without motion shall prescribe a different time. They shall in all other respects conform to the requirements of §§1.15 to 1.17, inclusive.

(f) Notice and action on petitions

(1) Notice and service. Petitions to intervene, when tendered to the Commission for filing, shall show service thereof upon all participants to the proceeding in conformity with §1.17(b).

(2) Action on petitions. As soon as practicable after the expiration of the time for filing answers to such petitions or default thereof, as provided in paragraph (e) of this section, the Commission will grant or deny such petition in whole or in part or may, if found to be appropriate, authorize limited participation. No petitions to intervene may be filed or will be acted upon during a hearing unless permitted by the Commission after opportunity for all parties to object thereto. Only to avoid detriment to the public interest will any presiding officer tentatively permit participation in a hearing in advance of, and then only subject to, the granting by the Commission of a petition to intervene.

(g) Limitation in hearings. Where there are two or more interveners having substantially like interests and positions, the Commission or presiding officer may, in order to expedite the hearing, arrange appropriate limitations on the number of attorneys who will be permitted to cross-examine and make and argue motions and objections on behalf of such interveners."

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FEDERAL POWER COMMISSION
BUREAU OF NATURAL GAS
DRAFT ENVIRONMENTAL IMPACT STATEMENT
SUMMARY SHEET

(1)

Distrigas Corporation, Distrigas of Massachusetts Corporation

DOCKET NOS. CP76-9 - Distrigas Corporation
CP73-135 - Distrigas of Massachusetts Corporation
CP74-137 - Distrigas of Massachusetts Corporation
CP74-227 - Distrigas Corporation

1. This Draft Environmental Impact Statement (DEIS), prepared by the staff of the Federal Power Commission, is related to an administrative action.

2. The administrative action here involved arises from applications by Distrigas Corporation (Distrigas) seeking authorization pursuant to Section 3 of the Natural Gas Act to import liquefied natural gas (LNG) from Algeria to the Distrigas of Massachusetts Corporation (DOMAC) LNG marine terminal located at Everett, Massachusetts, and requesting certification pursuant to Section 7 of the Natural Gas Act to sell the imported natural gas in interstate commerce in both liquid and vapor form. Concurrent with the Distrigas applications, DOMAC has filed an application, under protest, seeking certification pursuant to Section 7 of the Natural Gas Act to construct and operate certain facilities necessary to unload, store, revaporize, and distribute the imported LNG. This application seeks approval for the construction and operation of an unloading dock, a 374,000-barrel LNG tank, a 600,000-barrel LNG tank, and vaporizer units on the north bank of the Mystic River in Everett, Massachusetts.

3. Environmental impact would occur with respect to effects on man, land use, wildlife, water quality, air quality, and noise levels.

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4. Alternative siting of the LNG terminal as well as alternative sources of gas and the alternative of abandoning the terminal are considered herein.

5. Copies of this Draft Environmental Impact Statement are being made available to the public and all parties involved in the proceedings on or about February 3, 1976 and to the following agencies for their comments:

A. Federal:

Council on Environmental Quality
Environmental Protection Agency
Department of the Interior
Department of Commerce
Department of Army
Department of Agriculture
Department of Transportation
Department of Health, Education, and Welfare
Department of Housing and Urban Development
U.S. Energy Research and Development Administration
Nuclear Regulatory Commission
Advisory Council on Historic Preservation
Federal Energy Administration

B. State:

Massachusetts Executive Office of Administration and Finance
Massachusetts Historical Commission
Massachusetts Division of Water Pollution Control
Massachusetts Water Resources Commission
Massachusetts Executive Office of Environmental Affairs
Massachusetts Department of Public Utilities
Massachusetts Department of Public Safety
Massachusetts Department of Agriculture
Massachusetts Department of Natural Resources
Massachusetts Department of Public Health
Massachusetts Department of Public Works
Massachusetts Division of Fisheries and Game
Massachusetts Executive Office of Consumer Affairs

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Massachusetts Office of State Planning
& Management
Metropolitan Area Planning Council
Massachusetts Power Plant Siting Commission

C. Local:

Massachusetts Audubon Society, Inc.
Massachusetts Association of Conservation
Commission
Massachusetts Forest and Park Association
U.S. Coast Guard Captain of the Port of Boston
Sierra Club Eastern Representative
Honorable Edward M. Kennedy
Honorable Edward W. Brooke
U.S. Representative James A. Burke
Mayor of Boston, Kevin H. White
Boston Fire Department
Everett Central Fire Station
Chelsea Fire Department
Winthrop Fire Department
Industrial Union of Marine and Shipbuilding
National Marine Engineers' Beneficial
Exxon Terminal Supervisor
Dr. Richard Wilson, Harvard University
The Daily Item, Port Chester, New York

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1. DESCRIPTION OF THE PROPOSED ACTION

On November 20, 1972, Distrigas filed an application in Docket No. CP73-135 for a certificate of public convenience and necessity seeking authorization to sell approximately 5.1 trillion Btu's per year of the LNG which Distrigas was authorized to import in Federal Power Commission Opinion No. 613, issued March 9, 1972. 1/ Sales would be made from the Everett terminal to Brooklyn Union Gas Company (Brooklyn Union), Connecticut Gas Company (Connecticut Gas), Providence Gas Company (Providence Gas), New Jersey Natural Gas Company (New Jersey Natural), South Jersey Gas Company (South Jersey Gas), Valley Gas Company (Valley Gas), Boston Gas Company (Boston Gas), Bay State Gas Company (Bay State Gas), Fall River Gas Company (Fall River Gas), and Haverhill Gas Company (Haverhill Gas).

In FPC Opinion No. 613 issued March 9, 1972, the Commission declined to take jurisdiction over the construction and operation of the Everett and Staten Island LNG terminal, storage, and gasification facilities because at that time, Distrigas proposed to operate primarily in intrastate commerce. However, Distrigas' new applications make it clear that it now proposes to operate in interstate commerce. Therefore, Distrigas was directed by Commission order, dated May 25, 1973, to file an application to construct and operate LNG terminals at Everett, Massachusetts, and Rossville, Staten Island, New York. Distrigas filed for a rehearing with the Commission on this order. The Commission denied Distrigas' request for a rehearing on June 20, 1973. Distrigas has since appealed the order of May 25, 1973, to the Washington, D. C. Court of Appeals. On August 16, 1973, the Court stayed the Commission's order pending further order of the Court. On November 15, 1973, DOMAC filed an application in Docket No. CP74-137, under protest, for a certificate of public convenience and necessity to construct and operate LNG terminal, storage, and gasification facilities at Everett, Massachusetts.

1/ Distrigas was authorized to import in Docket No. CP70-196, et al., which is the subject matter of Opinion No. 613, volumes of LNG equivalent to 15.4 trillion Btu's/year over a period of 20 years from Algeria to terminals located at Staten Island, New York and Everett, Massachusetts.

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On March 4, 1974, Distrigas filed an application in Docket No. CP74-227 for a certificate of public convenience and necessity to sell sufficient quantities of imported Algerian LNG to satisfy its affiliate, DOMAC, full LNG requirements for resale to third parties, as detailed in Docket Nos. CP73-135 and CP74-137. At the same time, DOMAC was substituted for Distrigas as party applicant in CP73-135.

On July 8, 1975, Distrigas filed an application in Docket No. CP76-9 for authorization to import, over an 18-month period, 21 trillion Btu's of LNG to the DOMAC terminal in Everett. To date, no application to sell this volume of LNG has been filed before the Federal Power Commission.

The purpose of the Everett facilities would be to unload from LNG vessels, store, reload onto barges or trailer trucks, and revaporize LNG, and transport, in part, this revaporized gas into both interstate and intrastate commerce. The volumes of gas, in liquid or vapor form, proposed for sale in Docket No. CP73-135 are shown in Table 1. At present, Boston Gas has intrastate pipelines connected to the Everett terminal. The volumes, mode, destination and frequency of deliveries of LNG and revaporized gas for each customer from the Everett facility are given in Table 2 for the volumes associated with Opinion No. 613. The customers would arrange for cryogenic truck transportation to their own facilities. Table 3 summarizes the past and anticipated future sales of LNG through the DOMAC facility under these applications.

During the 18-month period beginning July 1, 1976, and ending December 31, 1977, Distrigas proposes in Docket No. CP76-9 to import, sell and deliver 950,000 cubic meters of LNG in addition to the approximately 1,000,000 cubic meters of LNG[2/] expected under the imports approved in Docket No. CP70-196 for that same period. These additional volumes are expected to arrive as follows:

- 200,000 cubic meters between July 1, 1976, and December 31, 1976
- 300,000 cubic meters between January 1, 1977, and June 30, 1977
- 450,000 cubic meters between July 1, 1977, and December 31, 1977

The sale and delivery will be spread approximately evenly over each of the three periods.

2/ One cubic meter of LNG is equivalent to 22.35 million Btu's of natural gas.

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TABLE 1

VOLUMES OF GAS PROPOSED FOR SALE IN DOCKET NO. CP73-135

Customer	CONTRACT YEARS (beginning April 1) First Year (million Btu's)	Second Year (million Btu's)	Third Year & Following (million Btu's)
Brooklyn Union Gas Company	2,500,000	2,500,000	2,500,000
Connecticut Gas Company	500,000	500,000	500,000
Providence Gas Company	800,000	900,000	900,000
New Jersey Natural Gas Company		400,000	500,000*
South Jersey Gas Company	200,000	400,000	600,000
Valley Gas Company	120,000	120,000	120,000
Total	4,120,000	4,820,000	5,120,000*

* Of this quantity, 400 billion Btu's will be sold under a short-term agreement with New Jersey Natural Gas Company.

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Table 2

VOLUMES, MODE, PATTERN AND DESTINATION OF LNG DELIVERIES OUT OF EVERETT, MASSACHUSETTS TERMINAL

Customer	Delivery Mode	Destination	Annual Quantity (BBtu)	Approx. Delivery Pattern & Frequency
Boston Gas Co.	Vapor	Everett, Mass.	3,657	Uniform, Dec. thru March
	Truck	Boston, Lynn, or Salem, Mass.	1,083	170 Trucks/mo. April thru November
	Boil-Off	Everett, Mass.	238	As generated and not otherwise sold to Boston Gas as vaporized LNG.
Bay State Gas Co.	Truck	Easton, Mass.	900	94 Trucks/mo.
Brooklyn Union Gas Co.	Vapor by displacement	Brooklyn, N.Y.	4,700	500 BBtu/mo. Nov. thru Mar. and remainder uniformly, April thru Oct.
Connecticut Gas Co.	Truck	To be arranged	500	50 Trucks/mo.
Fall River Gas Co.	Truck	Fall River, Mass.	150	45 Trucks/mo., Jan. & Feb. 15 Trucks/mo., Dec. & March 8 Trucks/mo., April thru November
Haverhill Gas Co.	Truck	Haverhill, Mass.	100	10 Trucks/mo.
New Jersey Natural Gas Co.	Truck	Manahawkin or Farmingdale, N.J.	100	10 Trucks/mo.
Providence Gas Co.	Truck	Prov. or Exeter, R.I.	900	94 Trucks/mo.
South Jersey Gas Co.	Truck	McKee City, N.J.	600	63 Trucks/mo.
Valley Gas Co.	Truck	Cumberland, R.I.	120	38 Trucks/mo., Dec. thru March

TOTAL FIRM SALES & BOIL-OFF	13,048	
LNG TO BE SOLD	1,299	
TOTAL LNG SOLD	14,347	
LOSSES	564	
USES	209	
TOTAL LNG PURCHASED	15,120	(BBtu's)

It should be noted that transportation of LNG by truck and barge is considered nonjurisdictional by the FPC. See the FPC rulemaking in Docket No. R-377 issued May 4, 1973.

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TABLE 3

LNG Purchases - Historical and Projected

Customer	Annual Volumes (BBtu) - Fiscal Year[1] Basis					
	Actual			Projected		
	1972	1973	1974	1975[2]	1976	Thereafter
Bay State Gas[3]	482	66	142	180	762	900
Boston Gas	881	300	1,123	416	3,319	4,978
Brooklyn Union Gas			583		4,368	4,700
Cape Cod Gas			257			
Connecticut Gas	171	33			523	500
Fall River Gas	162	5	28	20	99	150
Haverhill Gas	18		26	20	86	100
Mystic Valley Gas[4]	98	130	228			
NEGEA	6					
New Jersey Natural Gas					106	100
North Shore Gas[4]			36			
Providence Gas	161	234	129		942	900
South Jersey Gas		13	38		628	600
Springfield Gas			45			
Valley Gas			14		66	120
Total Firm Sales & Boil Off						13048

1/ The fiscal year for Distrigas and DOMAC begins Oct. 1, 1975.

2/ Assumes three cargoes arrive prior to Sept. 30, 1975. Entitlements of all other long term customers of LNG in first three cargoes to be delivered after Sept. 30, 1975.

3/ Formerly Brockton-Taunton Gas Company.

4/ Now a division of Boston Gas Company.

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The original certificate applications for operation of the Everett LNG terminal included a proposal for making deliveries to customers with the 4,767-cubic meter barge "Massachusetts". In subsequent amendments the applicant withdrew this proposal and contended that all customer deliveries would be either by cryogenic truck or in vapor form. However, in anticipation of possible future barge deliveries, description of the originally proposed vessel has been retained in this impact statement. This information is intended to be used as reference material and should not be treated as part of the present application for certification before the Commission.

In CP76-9, the applicant indicated a variety of LNG tanker vessels that may be utilized in that proposal, the largest being of a 120,000-cubic meter capacity. General specifications of these ships are included in Table 4. The description in Section 4 for the "Benjamin Franklin" and the "Descartes" would generally apply for the other vessels listed in Table 4.

The existing Everett LNG terminal is located on a 37-acre tract of land on the north bank of the Mystic River, just below the Malden Bascule Bridges, Middlesex County, Everett, Massachusetts. Figure 1 is a development plan of the DOMAC site and surrounding properties. The terminal consists of a berth and wharf along and parallel to the Mystic River, mooring and unloading facilities, a 374,000-barrel 3/ (59,400 cubic meter) and a 600,000-barrel (95,300 cubic meter) LNG storage tank with a common diked enclosure around the two storage tanks, two truck-loading stations, vaporization and metering facilities, fire protection equipment, and other appurtenant facilities. A simplified flow diagram of the DOMAC terminal is shown in Figure 2. A plot plan showing the spacing relationships among terminal facilities is shown in Figure 3.

3/ One barrel is equivalent to 42 U.S. gallons and would contain 3.55 million Btu's of natural gas, based on 1,020 Btu/ft^3 for natural gas. Also, there are 35.3 cubic feet per cubic meter. A listing of the properties of LNG is shown in Appendix A.

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TABLE 4

SHIP SPECIFICATIONS

	Descartes	Venator & Lucian	Kentown[a] & Montana[b]	Norman Lady & LNG Challenger	Tellier & Hassi R'Mel	Ben Franklin	Massachusetts 2/ (Towed Barge)
Capacity (m^3)	50,000	29,000	35,000	87,600	40,109	120,000	4,420
Practical delivery capability (m^3) 1/	47,000	27,260	32,900	82,344	37,702	112,800	-
Speed (knots)	17	19.7	20	19	17.5	18.5	-
Typical trips per 6-month period	8	9	9	9	8	9	-
Delivery capability (m^3) (6 months)	376,000	245,340	296,000	741,096	301,616	855,000	-
Length	721' 10"	589' 8"	651' 3"	818' 6"	656'	904' 6"	297' 0"
Beam	104' 7"	94'	87'	131' 3"	96'	136' 6"	60' 0"
Draft	30' 2"	27'	29' 4"	34' 6"	26'	35'	15' 6"
Design	Conch Ocean/Technigaz	Kvaerner Moss	Gaz Transport	Kvaerner Moss	Gaz Transport	Conch Ocean	-
Flag	French	Norwegian	a-British b-U.S.A.	British	Algerian	French	U.S.A.
Membrane/tank material	Stainless steel	Aluminum	Invar	9% nickel steel	Invar	Stainless steel	Aluminum
Insulation	Balsa wood	Polystyrene	Perlite	Polystyrene	Perlite	Balsa wood	Perlite

1/ Basis: 6% retained heel and transit loss.

2/ This vessel is not planned to be used for presently scheduled deliveries.

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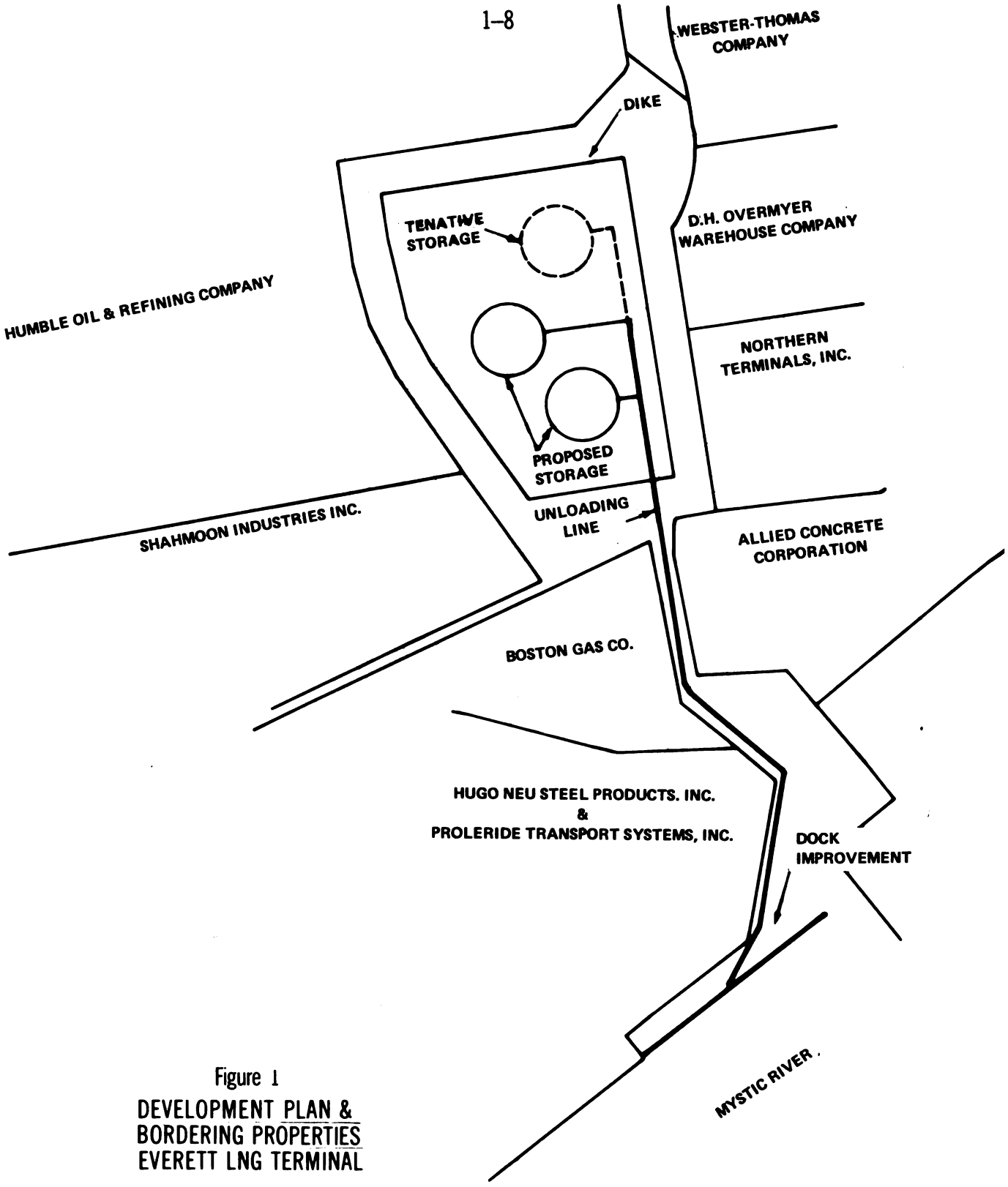

Figure 1

DEVELOPMENT PLAN & BORDERING PROPERTIES EVERETT LNG TERMINAL

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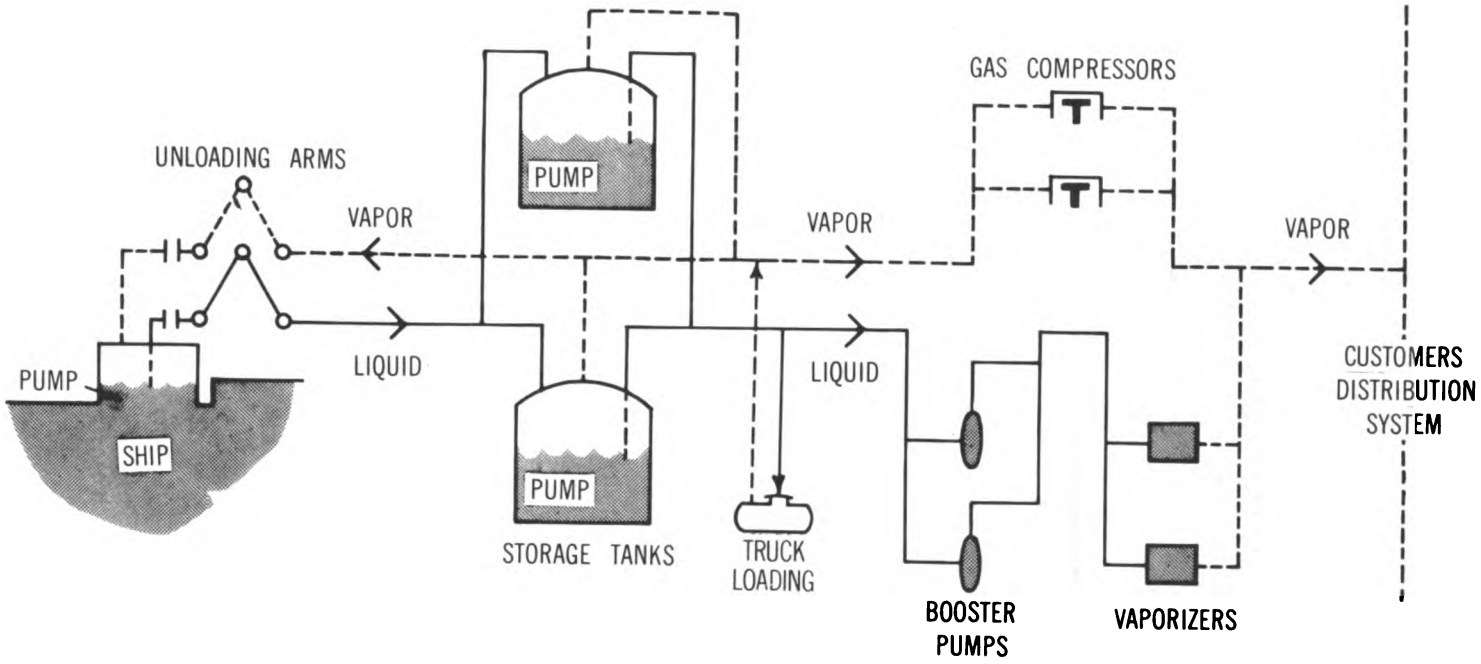

SIMPLIFIED FLOW DIAGRAM

FIGURE 2

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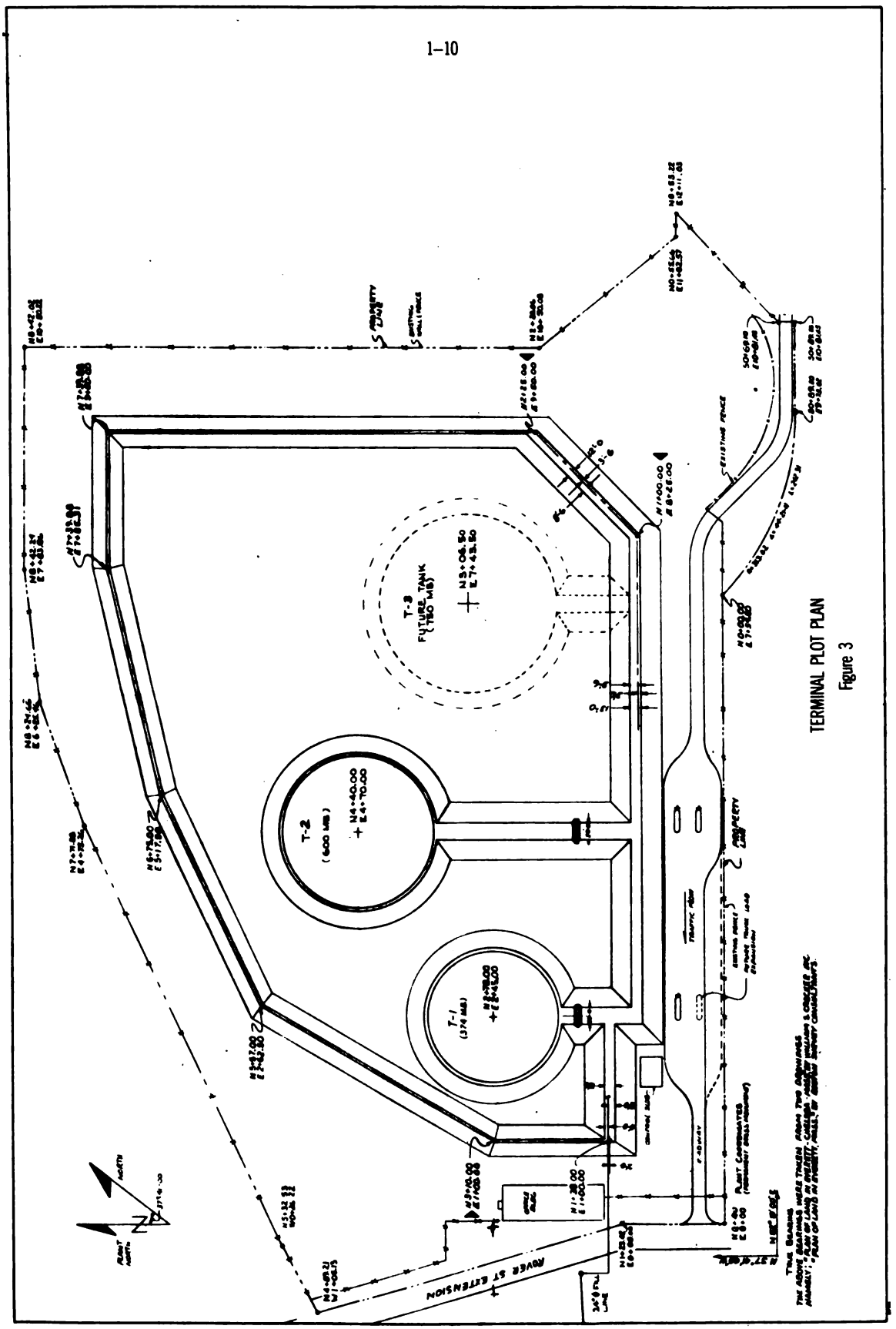

TERMINAL PLOT PLAN

Figure 3

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The DOMAC LNG marine terminal is designed to receive LNG from the 50,000-cubic meter 4/ cryogenic tanker, the "Descartes," the 120,000-cubic meter cryogenic tanker, the "Benjamin Franklin," and load the 30,000-barrel (4,767 cubic meter) barge, the "Massachusetts." (See Figure 4.) The Descartes and the "Hassi R'Mel" have already made voyages and discharged LNG cargoes at the Everett terminal. The characteristics of the "Descartes," "Ben Franklin," "Hassi R'Mel," and "Massachusetts," as well as those vessels which may be utilized in Docket No. CP76-9, are given in Table 4. A schematic diagram of the 30,000-barrel barge is shown in Figure 5.

A pilot would board all LNG carriers entering Boston Harbor in the vicinity of Presidential Roads. The ship would move into the harbor and up the Mystic River. Both the Boston Inner Harbor and the DOMAC docking facilities would have a minimum depth of 36 feet at mean low water. Attached as Figure 6 is a nautical chart of Boston Inner Harbor. Ship movements are at present restricted to daylight hours only and further limited to the period from 2 hours before to 2 hours after high water by the U.S. Coast Guard. Speed restrictions and other harbor maneuvering requirements for these cargo vessels are also determined by the U.S. Coast Guard.

Three 12-inch diameter counter-weighted marine unloading arms (see Figure 7) designed to function with allowances for tide variations and outward and parallel ship movements would connect to the unloading system of the LNG ship. Two of the marine arms would be used for liquid unloading and the third arm used as a vapor return line to the ship so that a positive pressure is maintained in the ship's tanks. For barge loading, the LNG would be pumped through the vapor return arm to the barge and vapor would be returned through one of the loading arms. The "Descartes" would unload its cargo at a flow rate of 15,000 gpm (56.8 cubic meters per minute) while the "Ben Franklin", which has a discharge capability of 38,000 gpm (143.8 cubic meters per minute) would unload at a flow rate of 33,600 gpm (127.1 cubic meters per minute). Barge loading would be accomplished at a flow

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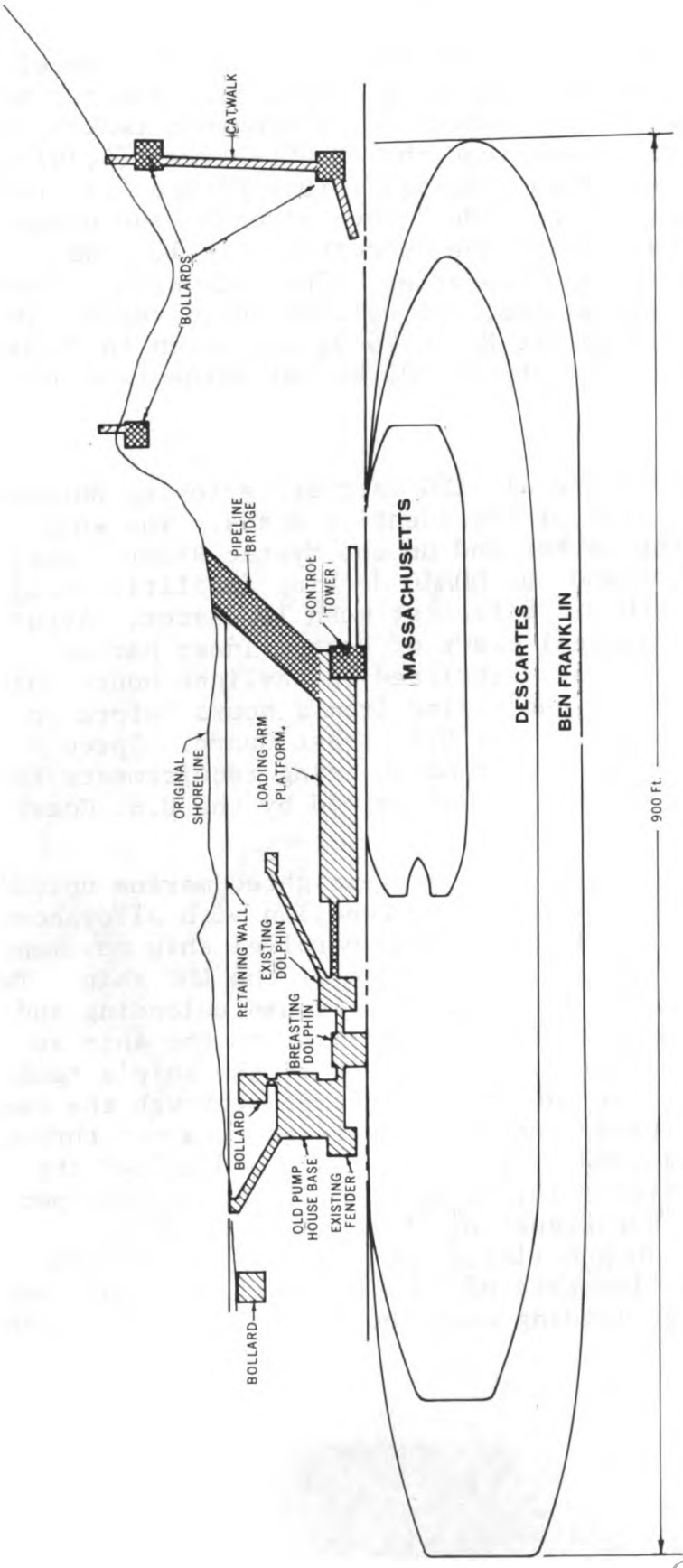

SCHEMATIC OF DOCKING FACILITIES

Figure 4

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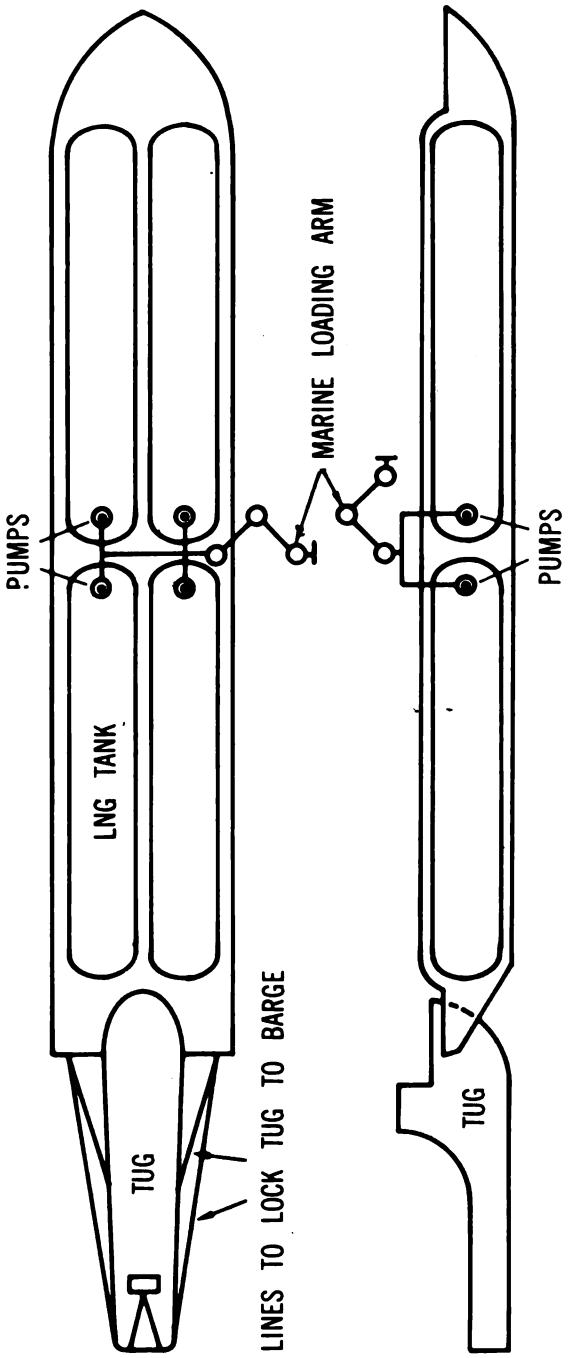

LNG BARGE

Figure 5

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SOUNDINGS IN FEET

Figure 6

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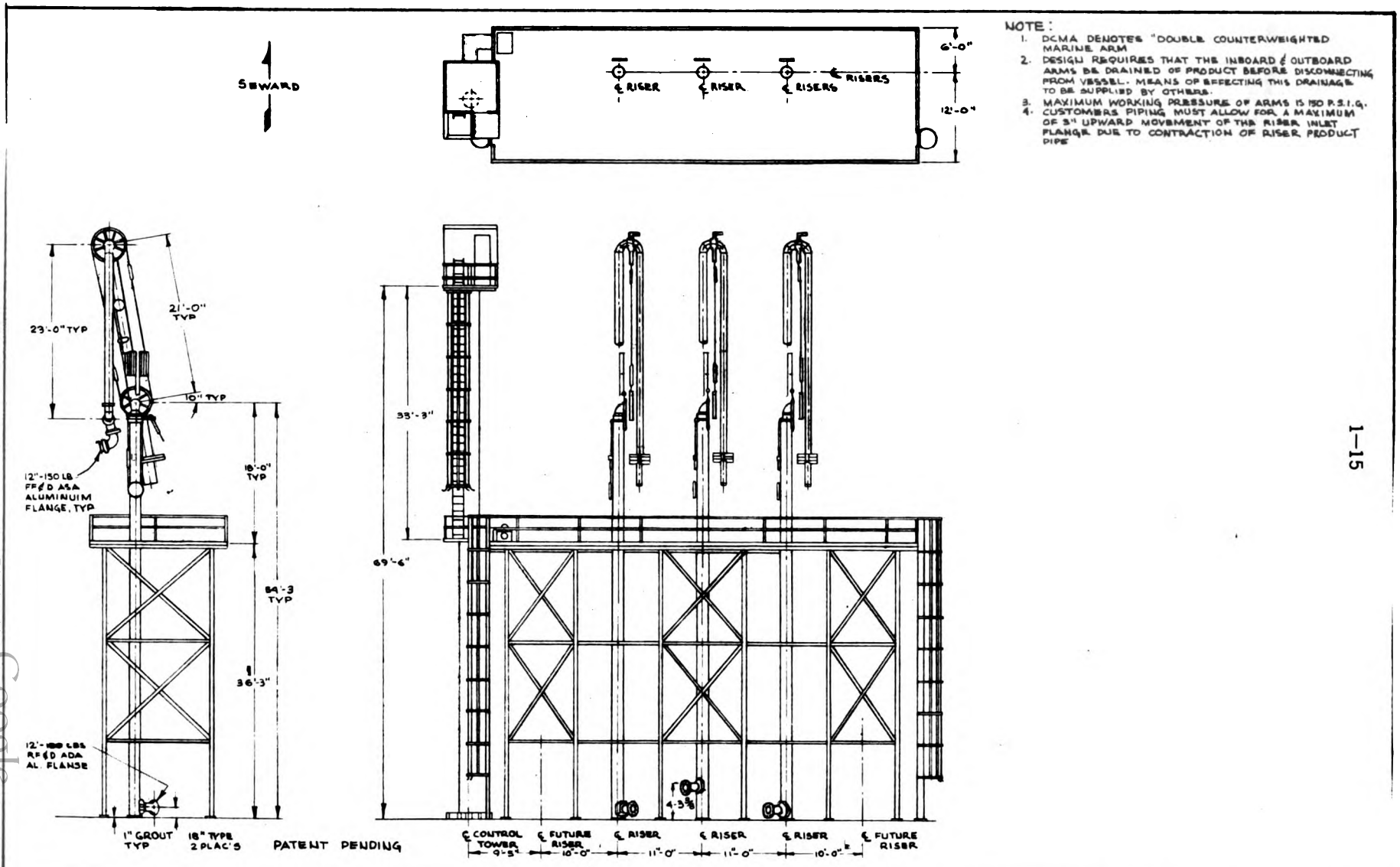

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Marine Unloading Arms and Platform
Figure 7

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rate of 5,250 gpm (19.8 cubic meters per minute). A 24-inch diameter insulated liquid transfer line extends from the dock approximately 1,000 feet to each of the storage tanks with a combination 12 and 14-inch vapor return line extending from the storage tanks back to the dock. Loading of the storage tanks would be accomplished through the top of each tank with provisions made for recirculation and intertank transfer of LNG when this is desirable to achieve mixing.

The 374,000 and 600,000-barrel storage tanks are comprised of an inner tank which is subjected to cryogenic temperatures and hydrostatic pressures of the LNG in storage and a vapor tight outer tank for containing internal gas pressure as well as for retaining the insulation which surrounds the inner tank. (See Figure 8.) The inner tank is constructed of 9 percent nickel steel and is surrounded by a 3-foot layer of loose fill, expanded perlite, and a resilient fiberglass blanket of insulation. Around this insulation would be a carbon steel outer tank consisting of a vertical cylindrical shell, flat bottom, and a self-supporting roof. The inner tank also consists of an insulated hanging deck supported from the roof of the outer tank. Between the inner 9 percent nickel steel tank and outer carbon steel bottoms are Foamglas blocks utilized as load-bearing insulation. A concrete ringwall foundation is provided for each tank, and electric foundation heating systems automatically maintain the temperature of the ground above the freezing temperature ($32^{o}F$). The 374,000-barrel tank has an inner tank diameter of 150 feet with a vertical shell height of 123 feet 11 inches. The outer tank is 156 feet in diameter and has a vertical shell height of 131 feet 6 inches, plus the dome which adds 27 1/2 feet to the height. The 600,000-barrel tank has an inner tank diameter of 184 feet with a vertical shell height of 132 feet 3 inches. The outer tank is 190 feet in diameter with a 138 foot 6 inch vertical shell height plus an additional dome height of 33 1/2 feet. The liquid level heights for the 374,000 and 600,000-barrel tanks are 119 feet 7 inches and 127 feet 8 inches, respectively. Both tanks are designed for earthquake loads in accordance with the Uniform Building Code - Zone 2 and would be capable of sustaining a 124 mph wind and a snow live roof load of 30 pounds per square foot. This snow load would correspond to approximately 55 inches of snow (based on wet snow density equal to liquid water). Since the design of the two LNG storage tanks, the Boston area has been reclassified as a

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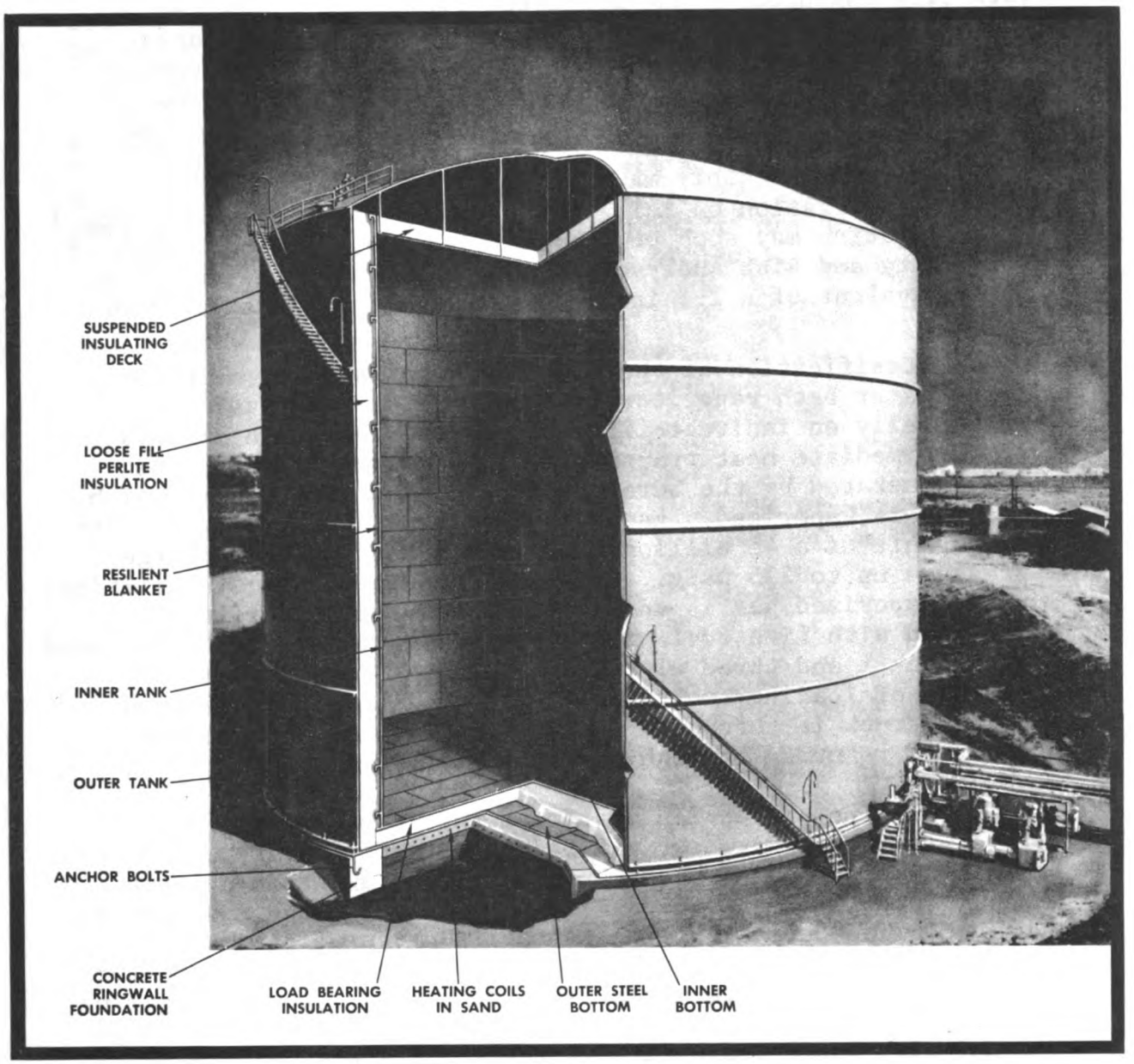

Cutout View of LNG Storage Tank
Figure 8

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Zone 3 seismic area. Praeger Kavanagh Waterbury, a New York City engineering and architect firm, was contracted by Distrigas to determine if the design of the Everett tanks was sufficient to withstand the heavier earthquake intensity associated with the new Zone 3 seismic rating for the Boston area. The conclusion reached by Praeger Kavanagh Waterbury was "that the tanks as constructed would withstand forces induced by the probably maximum earthquake near the site." Staff investigation on this issue has indicated that the Zone 3 seismic rating may soon be reclassified again by the Branch of Seismicity and Risk Analyses of the U.S. Geological Survey to the equivalent of a 1.5 in the present zoning classification.

Gasification of the LNG is accomplished by means of three water bath vaporizers. A water bath vaporizer is essentially an indirect-fired heat exchanger which employs an intermediate heat transfer medium (water) to carry the heat generated by the burning fuel to the tubes within which the LNG is vaporized. Each vaporizer at the Everett facility is capable of a 45 billion Btu/day send-out at a discharge pressure up to 275 psig. Prior to send-out to local utilities, the revaporized gas is odorized. The Everett facility is equipped with five dual truck-loading stations - two associated with Tank 1 and three with Tank 2. Each station would be capable of loading two trucks per hour. Liquid connection to the truck is through a 3-inch insulated metal hose, and vapor is returned through a 2-inch hose.

The fire protection system at the site consists of a fire prevention network, a fire/gas detection system, and a fire extinguishing network. The fire prevention network has incorporated an equipment shutdown system and LNG shutoff valves. The detection of potential sources of fire and actual fires is accomplished using LNG vapor leakage monitoring systems and ultra-violet (UV) detectors. Upon triggering of any combustible gas detector, alarms would automatically sound, with appropriate fire supression systems being manually activated. The fire extinguishing network is comprised of a system to combat both LNG and conventional fires. Dry chemical units, both fixed and portable, are located in various areas of the terminal and dock areas to control LNG-fueled fires. A conventional firefighting system consisting of a hydrant network and portable hand extinguishers is also positioned around the site. This system is used to

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combat LNG fires and to cool the major terminal structures in the event of a large-scale fire.

The present storage facilities of the Everett terminal consist only of the 374,000 and 600,000-barrel LNG storage tanks. Future expansion plans indicate a third tank having a capacity of 750,000 barrels(see Figure 3), and two additional marine loading arms. DOMAC has not provided any initiation or completion dates for these expansion projects.

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2. DESCRIPTION OF THE EXISTING ENVIRONMENT

a. Location

DOMAC's LNG import facilities are located in Everett, Massachusetts, on a 37-acre site, as shown in Figure 6. It is situated on the north bank of the Mystic River about 1 mile west of the confluence of the Mystic and Chelsea Rivers, which forms the Boston Inner Harbor. Located within the general Boston metropolitan area, the storage and regasification facility site lies approximately 1,500 feet north of the Boston city limits, which run along the middle of the Mystic River and 1,000 feet west of the Island End River. The LNG tanker and barge docking facilities are sited on the north bank of the Mystic River 1,000 feet west of the mouth of the Island End River, and are connected by a 1,000-foot 24-inch diameter LNG pipeline that runs northeast to the storage facilities, and which makes an overhead crossing of Rover Street on the storage area's southern boundary. A spur line of the Boston and Maine Railroad forms the eastern boundary of the site, and the northern boundary lies 50 feet south of Beacham Street.

b. Land Use

Boston is one of the oldest centers of commerce and population in the United States. Though lacking in agricultural resources, the city's location near trade routes and fishing grounds was quickly exploited. At the center of development was Boston Harbor, serving the fishing fleets that took advantage of the coastal Massachusetts fishery resources, and the merchant men handling trade between the northern Colonies and Europe.

The Revolutionary War marked the end of unrestricted trade with Europe, and like the rest of New England at the beginning of the industrial revolution, Boston developed many manufacturing industries. The industrial boom that began during this period opened up jobs attracting many people to the Boston area and created growing suburbs and manufacturing zones around the city. Around the turn of the past century, industrial development

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began to decelerate and move out of the city. Because of its dependency on industry, Boston's economy and population began to decline. The city remained in a period of slight depression and slow growth until the 1940's, when technological research turned the industrial base to electronics and instrument manufacturing. In the past 20 years, Boston's industrial profile has reflected the diversification of the local economy and now contains a wide range of industries. Industrial expansion has generated new interest in renovating Boston Harbor facilities and adjacent industrial areas.

Currently, land in the vicinity of the existing Everett LNG terminal is used primarily for industrial, commercial, residential, and transportation corridor purposes. The last zoning study, conducted in 1963, found that residential use, concentrated in the northern half of Everett, comprised 47 percent of the total land use. Industry, occupying the southern waterfront portions, accounted for 44 percent of the total land use. The LNG terminal site, previously occupied by a gas manufacturing facility, is zoned industrial and is bordered by a scrap iron salvage yard to the southwest, several petroleum products tank farms to the north and northwest, warehouses to the northeast and east, and a gravel and building materials yard to the southeast. An electric generating station is located along the Mystic River approximately 2,000 feet west of the LNG docking facilities. According to the Massachusetts Department of Natural Resources, industrial zoning in the vicinity of the LNG terminal extends from the waterfront on the north shore of Mystic River 3,000 feet north to the far side of the Boston and Maine-Penn Central Railroad tracks. The border between the residential and industrial areas continues east and southeast along Second and Williams Streets to the northeast boundary of the U.S. Naval Hospital. To the west, land use is primarily industrial except for a small residential pocket located between Broadway and Robin Streets, 1,500 feet northwest of the project site.

Residential zones are found 1,500 feet northwest of the LNG storage site and 3,000 feet to the north and northeast, as mentioned previously. According to current census data, the majority of housing in Everett consists of multi-unit dwellings, which results in a relatively high population density as compared to single-unit dwellings. In light of the small amount of vacant land available for any type of development in Everett, it is unlikely that there will be any new housing constructed in the vicinity of the terminal other than urban renewal projects. The United States Department of the Navy operates a

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naval hospital located approximately 2,000 feet east of the storage tanks and 2,500 feet east of the docking area.

While industrial and residential uses account for the majority of land uses in the project area, there are parks and recreation facilities that serve as open space. There are three small city-owned playgrounds located within 2,000 feet west of the applicant's facilities--the Northern-Lynde-Dexter Street playground, the Bow Street playground, and the Franklin School playground. Also found within a 1-mile radius of the storage tanks are three other playgrounds and the Everett and Memorial Stadiums. Five boating facilities are situated at various points along the Mystic River. Currently, several comprehensive proposals for expansion and development of Boston's recreational resources are being drawn up for the area. A plan by the Metropolitan Area Planning Council would create a public walkway along the waterfront from a point on the Chelsea River east of the project to the U.S. Naval Hospital Grounds. It also calls for developing several Outer Harbor Islands along the LNG tanker routes as parks.

Everett, situated near the center of the Boston metropolitan area, is in the midst of the city's air, sea, rail, and highway system. Logan International Airport, New England's principal air terminal, is located approximately 2 miles southeast of the LNG tank site. Boston Harbor and its associated waterways constitute a major east coast center of shipping, carrying large volumes of industrial, commercial, and passenger ship traffic. Table 5 gives a breakdown of inbound and outbound traffic using the general harbor area. The principal components of the harbor are the Outer Boston Harbor, the Inner Boston Harbor, and the Charles, Mystic, and Chelsea Rivers. In 1973 , an estimated 12,223 vessels entered and 12,425 left the Port of Boston. Inbound-outbound traffic statistics for the main waterfront of the Port of Boston during the same year were 11,554 and 11,366 respectively. The Mystic and Chelsea Rivers receive a substantially smaller portion of harbor traffic. Approximately 1,727 vessels entered and 1,626 vessels left the Chelsea River in 1973. Upbound-downbound traffic figures for the Mystic River for 1973 were estimated at 1,269 and 1,248, respectively. While ship traffic for the Port of Boston as a whole covers a wide range of industrial and nonindustrial

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TABLE 5

TRIPS AND DRAFTS OF VESSELS

HARBOR OR WATERWAY / DRAFT (FEET)	DIRECTION: SELF PROPELLED VESSELS: PASSENGER AND DRY CARGO	SELF PROPELLED VESSELS: TANKER	SELF PROPELLED VESSELS: TOWBOAT OR TUGBOAT	NON-SELF PROPELLED VESSELS: DRY CARGO	NON-SELF PROPELLED VESSELS: TANKER	TOTAL
PORT OF BOSTON, MASS.				INBOUND		
41		1				1
40		18				18
39	1	95				96
38	1	31				32
37	1	39			1	41
36		52			3	55
35	3	59				62
34	2	95				97
33	13	99			8	80
32	23	97			8	88
31	19	65			7	91
30	34	27			4	65
29	50	28				78
28	32	27			1	60
27	51	32		10	2	95
26	64	26	1	4	1	96
25	70	17		1		88
24	58	17			1	76
23	69	10			6	85
22	65	3	1		9	78
21	60	7			8	75
20	58	4			20	82
19	42	5			7	54
18 AND LESS	6,838	897	2,395	68	560	10,710
TOTAL	7,554	1,591	2,357	75	646	12,223
MAIN WATERFRONT (PORT OF BOSTON)				INBOUND		
41		1				1
40		18				18
39	1	94				95
38	1	31				32
37	1	39			1	41
36		49			3	52
35	3	96				99
34	2	90				92
33	13	50			8	71
32	23	50			8	81
31	19	52			7	78
30	34	26			4	64
29	50	26				76
28	32	25			1	98
27	51	27		10	2	90
26	64	22	1	4	1	92
25	69	16		1		86
24	58	14			1	73
23	69	11			7	87
22	69	3	1		8	77
21	60	6			5	71
20	58	3			11	72
19	42	3			6	53
18 AND LESS	6,522	891	2,170	61	471	10,115
TOTAL	7,237	1,529	2,172	76	544	11,594
CHELSEA RIVER, MASS.				INBOUND		
38		1				1
37		2				2
36		21			1	22
35		33				33
34		21				21
33		28			8	36
32	1	25			8	34
31		30			7	37
30		9			4	13
29		13				13
28		11			1	12
27		15			2	17
26		10	1		1	12
25		8				8
24		7				7
23		6			3	9
22		2			6	8
21		2			5	7
20		2			9	11
19		3			7	10
18 AND LESS	10	390	736		278	1,414
TOTAL	11	639	737		340	1,727

HARBOR OR WATERWAY / DRAFT (FEET)	DIRECTION: SELF PROPELLED VESSELS: PASSENGER AND DRY CARGO	SELF PROPELLED VESSELS: TANKER	SELF PROPELLED VESSELS: TOWBOAT OR TUGBOAT	NON-SELF PROPELLED VESSELS: DRY CARGO	NON-SELF PROPELLED VESSELS: TANKER	TOTAL
PORT OF BOSTON, MASS.				OUTBOUND		
41						
40						
39		3				3
38	1					1
37	1	1				2
36		2				2
35	2	4				6
34	9	3				12
33	5	9			1	15
32	17	9			4	30
31	19	6			3	28
30	34	12			1	47
29	42	12				54
28	34	46			1	81
27	44	34				78
26	49	83	2	1	1	136
25	51	73			2	126
24	47	115			2	164
23	98	95			8	121
22	74	66	1		3	144
21	63	99			2	120
20	81	94			4	139
19	48	16			3	67
18 AND LESS	6,894	999	2,466	79	651	11,849
TOTAL	7,533	1,657	2,469	80	686	12,425
MAIN WATERFRONT (PORT OF BOSTON)				OUTBOUND		
41						
40						
39		3				3
38	1					1
37	1	1				2
36		2				2
35	2	3				5
34	9	2				11
33	5	8			1	14
32	17	9			3	29
31	19	5			3	27
30	34	12			1	47
29	42	9				51
28	34	46			1	81
27	44	26				70
26	49	71	2		1	123
25	91	92			2	105
24	47	81			2	130
23	98	95			7	120
22	74	62	1		3	140
21	63	63			3	129
20	81	65			5	151
19	48	17			2	67
18 AND LESS	6,545	898	2,850	76	489	10,858
TOTAL	7,224	1,490	2,853	76	523	11,366
CHELSEA RIVER, MASS.				OUTBOUND		
38						
37						
36						
35		1				1
34						
33		1				1
32		2			2	4
31		1				1
30		1				1
29		1				1
28		4				4
27		10				10
26		21	2		1	24
25		29			2	31
24		35			1	36
23		21			1	22
22		22			1	23
21		29			2	31
20		27			2	29
19		4			1	6
18 AND LESS	1	390	708		295	1,401
TOTAL	1	599	710		308	1,626

Source: Waterborne Commerce of the United States, Part 1
U.S. Army Corps of Engineers, 1973

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TABLE 5 (con't)

TRIPS AND DRAFTS OF VESSELS

HARBOR OR WATERWAY	DIRECTION						DIRECTION					
DRAFT (FEET)	SELF PROPELLED VESSELS			NON-SELF PROPELLED VESSELS		TOTAL	SELF PROPELLED VESSELS			NON SELF PROPELLED VESSELS		TOTAL
	PASSENGER AND DRY CARGO	TANKER	TOWBOAT OR TUGBOAT	DRY CARGO	TANKER		PASSENGER AND DRY CARGO	TANKER	TOWBOAT OR TUGBOAT	DRY CARGO	TANKER	
MYSTIC RIVER, MASS.				UPBOUND						DOWNBOUND		
40		3				3						
39		32				32						
38		14				14						
37		8				8						
36		7				7						
35	1	6				7	2	1				3
34		13				13	6					6
33		9				9	1	2				3
32	1	13				14	2	1				3
31	4	4				8	3					3
30	6	6				12	7	1				8
29	3	3				6	2	5				7
28	2	6				8	2	6				8
27	16	5		10		31	6	7				13
26	8	2		4		14	5	24		1		30
25	10	2		1		13	9	14				23
24	3	4				7	5	25				30
23	3	1				4	3	11				14
22	3				1	4	4	12				16
21	3					3	13	10				23
20	14					14	11	15			1	27
19	5					5	1	3				4
18 AND LESS	101	111	937	27	295	1,031	101	114	918	40	294	1,027
TOTAL	183	291	937	42	256	1,269	183	291	918	41	299	1,248

uses, the Chelsea and Mystic Rivers tend to carry a high percentage of industrial traffic, and waterfront land use along these waterways reflects this characteristic.

Several different rail lines pass within the vicinity of the Everett terminal facilities. Spur lines of the Boston and Maine Railroad (B&M) border the DOMAC property to the north and east and connect with a main rail line owned in part by B&M and Penn Central Railroad approximately 2,500 feet north of the LNG tanks. In addition, tracks of the Metropolitan Boston Transit Authority cross the Mystic River at the Malden Bridge, approximately 3,000 feet west of the DOMAC facilities.

The Everett terminal lies within the principal highway network of the Boston area. Interstate Highway 95 crosses the Mystic River, running north-south on the Mystic River Bridge, approximately 4,000 feet east of the LNG terminal. Massachusetts State Highway 99 crosses the Mystic River running north-south also on the Malden Bridge, and State Highway 16 extends east-west approximately 3,500 feet north of the terminal facilities. On the southern side of the Mystic River, Interstate 93 runs northwest-southeast and is located approximately 4,000 feet southwest of the docking facilities.

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Everett has lacked large quantities of vacant land available for development for the last two decades. Much of the new development that has occurred has been similar to the DOMAC facilities, in that a new industrial use has replaced an old industrial use in an industrially zoned area. Given the projected continuation of population decline, it is unlikely that any new residential development would be implemented by urban renewal and renovation. However, it is possible that with the present energy shortage, there would be a demand to convert less profitable waterfront industrial facilities to receive and process energy-related products. The present category and composition of land uses, and particularly the industrial-residential balance, is likely to remain the same, barring major unforeseen industrial and residential growth demand.

c. Physiography, Topography, and Geology

The DOMAC facilities are located within the Seaboard Lowland section of the New England Physiographic Province, an area characterized by low relief, gradually sloping upward to the west. Like all of the New England province, the existing land forms of the Seaboard Lowland have been shaped by glaciation and succeeding geologic processes. The portion of Massachusetts which includes the project area is a series of relatively flat plains that consist essentially of glacial outwash deposits, 40 to 50 feet deep, interrupted by numerous drumlins of glacial origin. At the eastern end of Massachusetts which includes the project area are the Boston Basin and Boston Harbor.

The present topography and geologic characteristics of the project area can be traced to tectonic activity in the post-Miocene Epoch, when a shift in the earth's crust created the Boston Basin. A large section of land "sank", forming a lowland plain surrounded by a ridge. In this period, several cycles of uplift and erosion left the softer bedrock of the Seaboard Lowland at a lower altitude than the harder crystalline rock to the west. During Pleistocene time, the region was glaciated at least once, and perhaps several times. The resulting glacial action eroded and smoothed existing hills and ridges, deposited a nearly continuous layer of glacial drift consisting of silt, gravel, sand, boulders, and clay,

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and left more than 100 drumlins in the Boston area. Subsequent aqueo-glacial and post-glacial fluvial processes deposited great quantities of silt, sand, and gravel to form outwash plains, kames, eskers, terraces, and lakebeds. In recent times, a gradual subsidence along the eastern seaboard inundated the lowest reaches of the stream valleys existing at that particular time. Fill projects in the last 200 years have drastically changed the configuration of the harbor area and have created several hundred acres of new land, including part of the proposed site.

As mentioned previously, all of the proposed facilities are located within the Seaboard Lowland section, and hence the separate facility locations vary little in elevation and topographic relief. The elevation(above mean sea level) of the LNG terminal site varies from a little more than 20 feet at its northeast corner to sea level at the docking area over a distance of roughly 2,500 feet. The closest point of any substantial elevation is the 110-foot drumlin occupied by the naval hospital, located 2,500 feet east of the terminal site.

The soil characteristics in the vicinity of the terminal are somewhat uniform in the sense that they originate from glacial deposition and are underlain by a bedrock of Cambridge Argillite. In general, the site is covered by a very loose to loose-mixed fill that can vary greatly in composition and density within short distances. Because the land was reclaimed from tidal flats and marshes, the area is generally underlain by peat and organic silt. The silt and peat are characteristically underlain by Boston Blue Clay. Core sampling conducted at ground elevations ranging from 17 to 20 feet above mean sea level encountered the following soil profile: ground surface to 18-21 feet below surface, very loose to loose grayish silty coarse to fine sand with wood and cinders (fill); 18-21 to 28-35 feet, very soft to soft organic silt and peat, with very stiff to hard silt encountered in some places; 28-35 to 55-69.5 feet, desiccated Boston Blue Clay, underlain by consolidated Boston Blue Clay; 55-69.5 feet, dense glacial till; and at 128-152 feet, bedrock is encountered.

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The area's geologic history of glaciation and submergence created hydrological features characteristic of frowned valleys and glacial ponds. The largest and most obvious of these is Boston Harbor and its tidal basin extensions, the Charles, Mystic, and Chelsea Rivers. Offshore of the docking area, the Mystic River is approximately 37 feet deep. Two smaller tidal rivers, the Malden and Island End, 6,250 feet northwest and 2,000 feet east of the docking area respectively, drain into the Mystic River from the north. Several unnamed ponds lie within a mile radius of the LNG terminal. Like many other areas with glacial topography, Everett has a high water table. The core samples taken for soil profile encountered groundwater at depths ranging from 7 to 10 feet below the surface, which correspond to elevations at approximately 10 to 15 feet mean sea level.

There are some active geologic processes and hazards endemic to the project area. Tides and currents in Boston Harbor and the Mystic River are eroding certain sections of shoreline and depositing sediment in other portions. The impact of these processes on the LNG docking facilities is probably minimized by bulkheads in place along the docking area, which would also minimize any hurricane-generated wave action and erosion.

Since the construction in 1971, the applicant has experienced no problems with differential compaction or related problems beneath the tanks that would endanger the integrity of the tanks. It is expected that soil compaction and settlement would not pose any more of a problem with increased LNG deliveries.

All regions within the continental United States, exclusive of Alaska, have been designated for seismic evaluation as Zone 0, 1, 2, or 3, as shown in Figure 9. Under this system, Zone 0 corresponds to the least active seismic area, as in southern Florida, while Zone 3 includes seismically active areas similar to those in California. Boston has been designated as being in a Zone 3 seismic risk area in the Uniform Building Code. However, the rationale behind this designation has been questioned by seismologists and is

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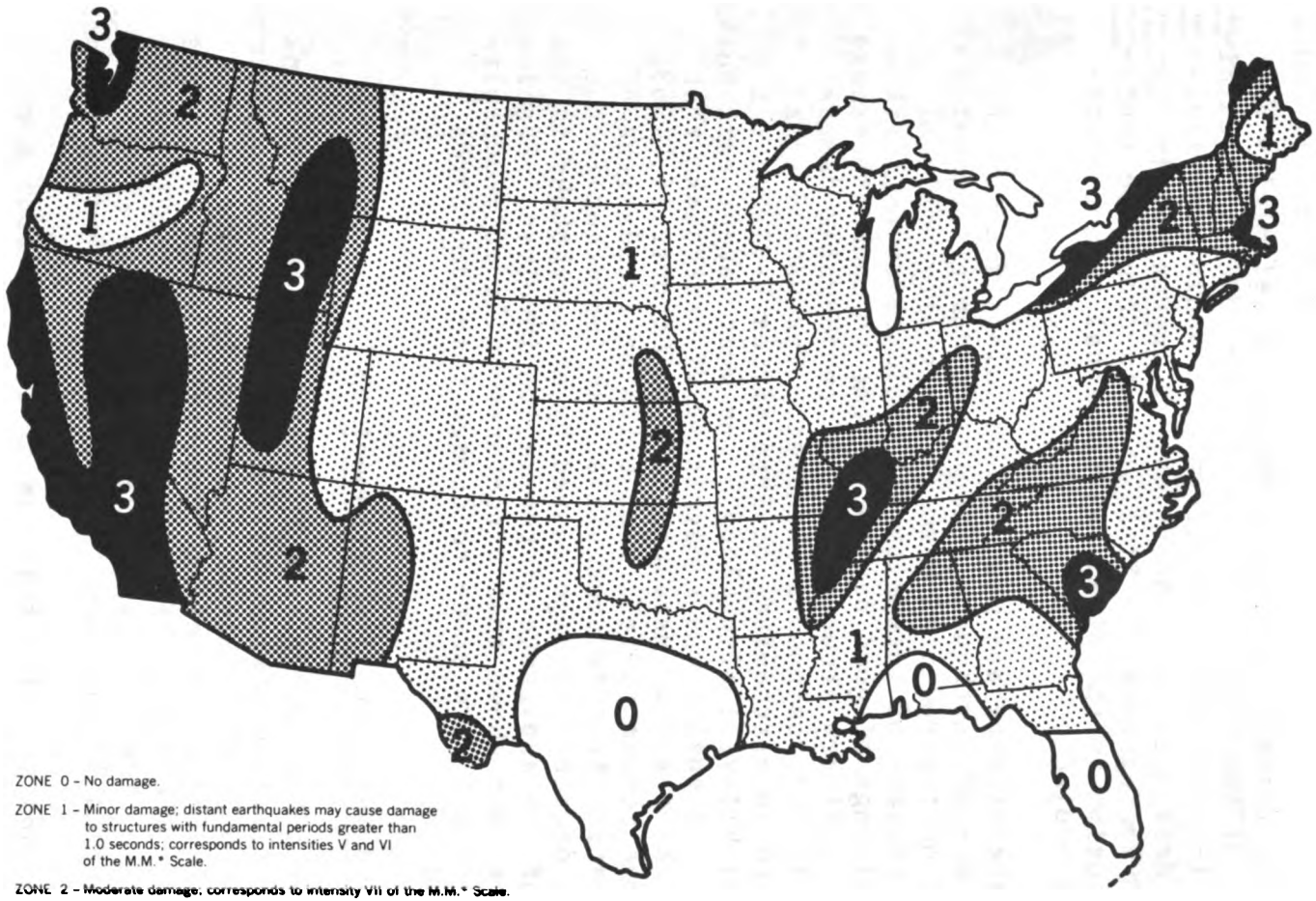
ZONE 0 - No damage.
ZONE 1 - Minor damage; distant earthquakes may cause damage to structures with fundamental periods greater than 1.0 seconds; corresponds to intensities V and VI of the M.M.* Scale.
ZONE 2 - Moderate damage; corresponds to intensity VII of the M.M.* Scale.
ZONE 3 - Major damage; corresponds to intensity VIII and higher of the M.M.* Scale.

Figure 9 —SEISMIC RISK MAP FOR CONTERMINOUS UNITED STATES.

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presently being reevaluated by the Branch of Seismicity and Risk Analysis of the U.S. Geological Survey (USGS). Preliminary results indicate that the Boston area would more realistically be designated the equivalent of approximately 1.5 on the 0 to 3 zoning system. Final results should be available for inclusion in the final environmental impact statement for this project.

Earthquake effects are measured and classified on the basis of degrees of earthquake effects and damage intensity from I to XII on the Modified Mercalli Intensity Scale of 1931. An earthquake of intensity VII would cause negligible damage in buildings of good design, slight to moderate damage in well-built ordinary structures, and considerable damage in poorly built and designed structures. The Boston area has experienced 10 earthquakes of intensities V-VI and three of intensities VII-VIII since 1663. The most recent earthquake of significant intensity was a magnitude VI earthquake that occurred off the coast of Massachusetts on October 16, 1963, and caused some stones to fall from building foundations across the Mystic River in Somerville. An important factor affecting the degree of damage caused by an earthquake is the composition of the substrate of the region involved. Studies of earthquakes have shown that structures built on unconsolidated substrate are more prone to damage than structures built on solid rock.

d. Aquatic and Terrestrial Environment

The Everett LNG import site is located on the north bank of the Mystic River approximately 1 mile west of the confluence of the Mystic and Chelsea Rivers, as shown in Figure 6. The Mystic River is one of the eight tributaries which enters the Boston Harbor. The depths of the harbor range from 10 to 50 feet at mean low tide, with an average tidal range of 9.4 feet. Figures 10 through 15 show the tidal currents of Boston Harbor.

Hydraulic and salinity features of Boston Harbor are controlled mainly by tides, and to a much lesser extent, by discharges of freshwater from tributaries. During periods of low precipitation, the freshwater discharge to the harbor is near 100 cubic feet per second (cfs). Except near the

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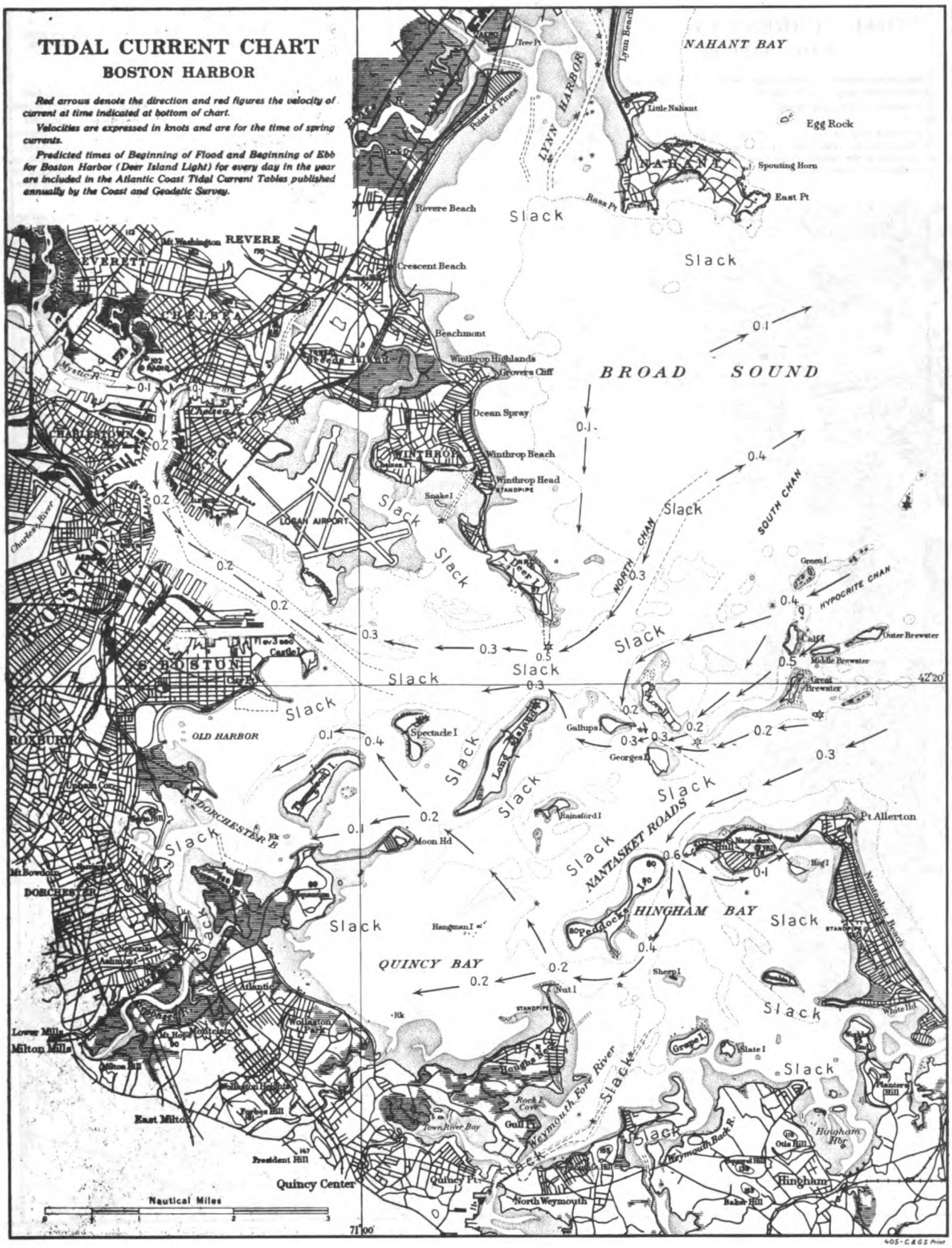

BEGINNING OF FLOOD AT DEER ISLAND LIGHT
($\frac{1}{2}$ hour after low water at Boston)

Figure 10

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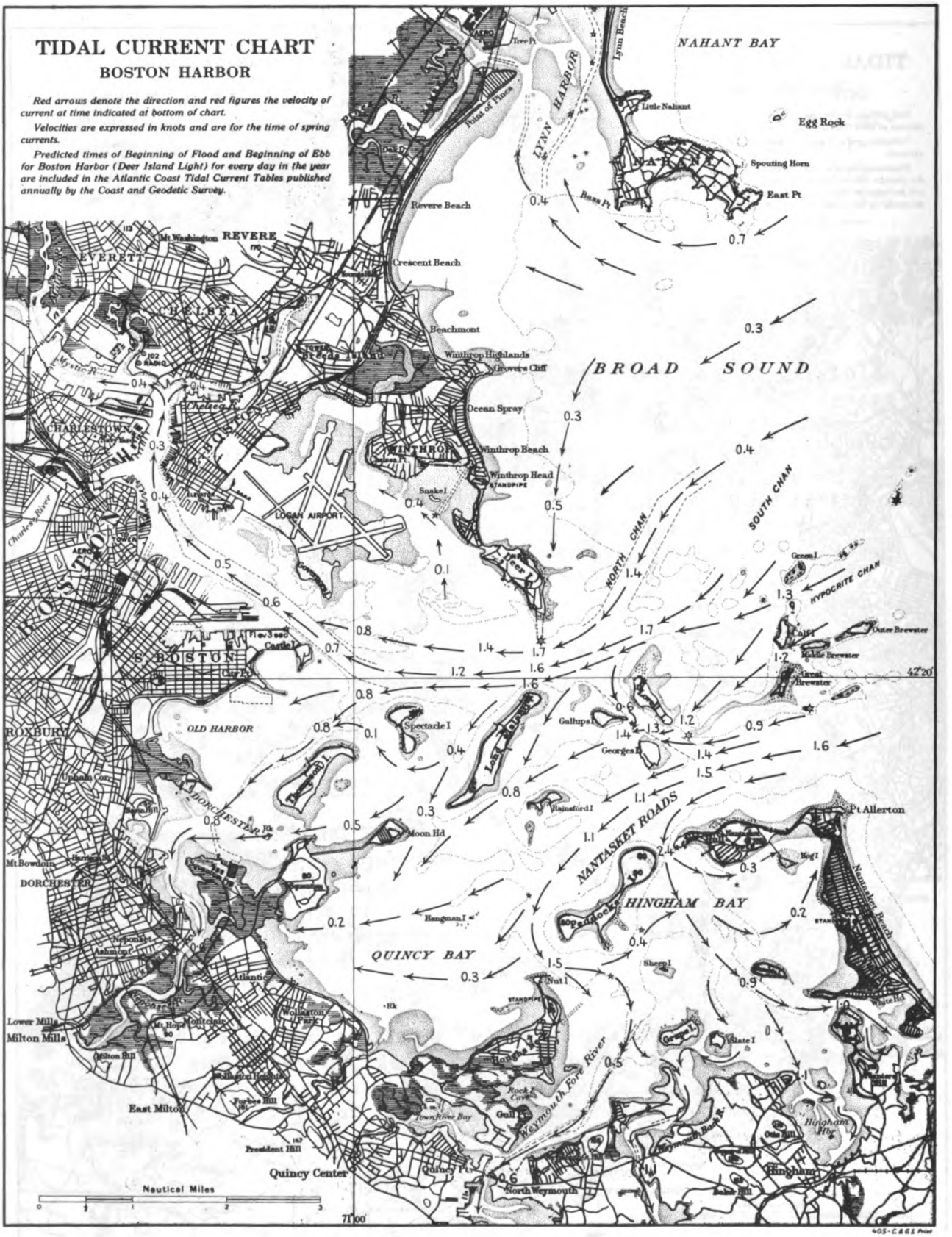

TWO HOURS AFTER BEGINNING OF FLOOD AT DEER ISLAND LIGHT

(2½ hours after low water at Boston)

Figure 11

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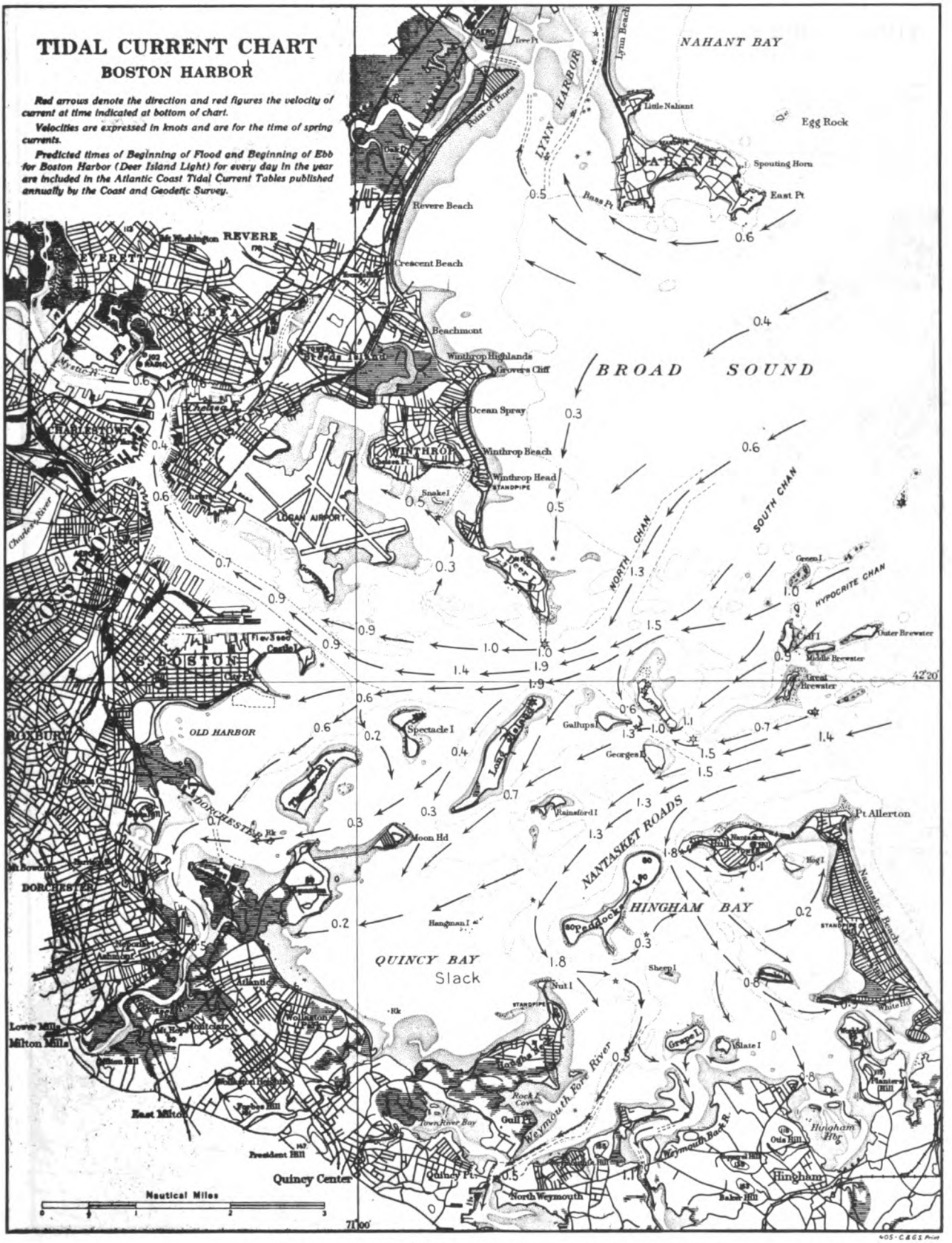

FOUR HOURS AFTER BEGINNING OF FLOOD AT DEER ISLAND LIGHT
(4½ hours after low water at Boston)

Figure 12

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BEGINNING OF EBB AT DEER ISLAND LIGHT
(High water at Boston)

Figure 13

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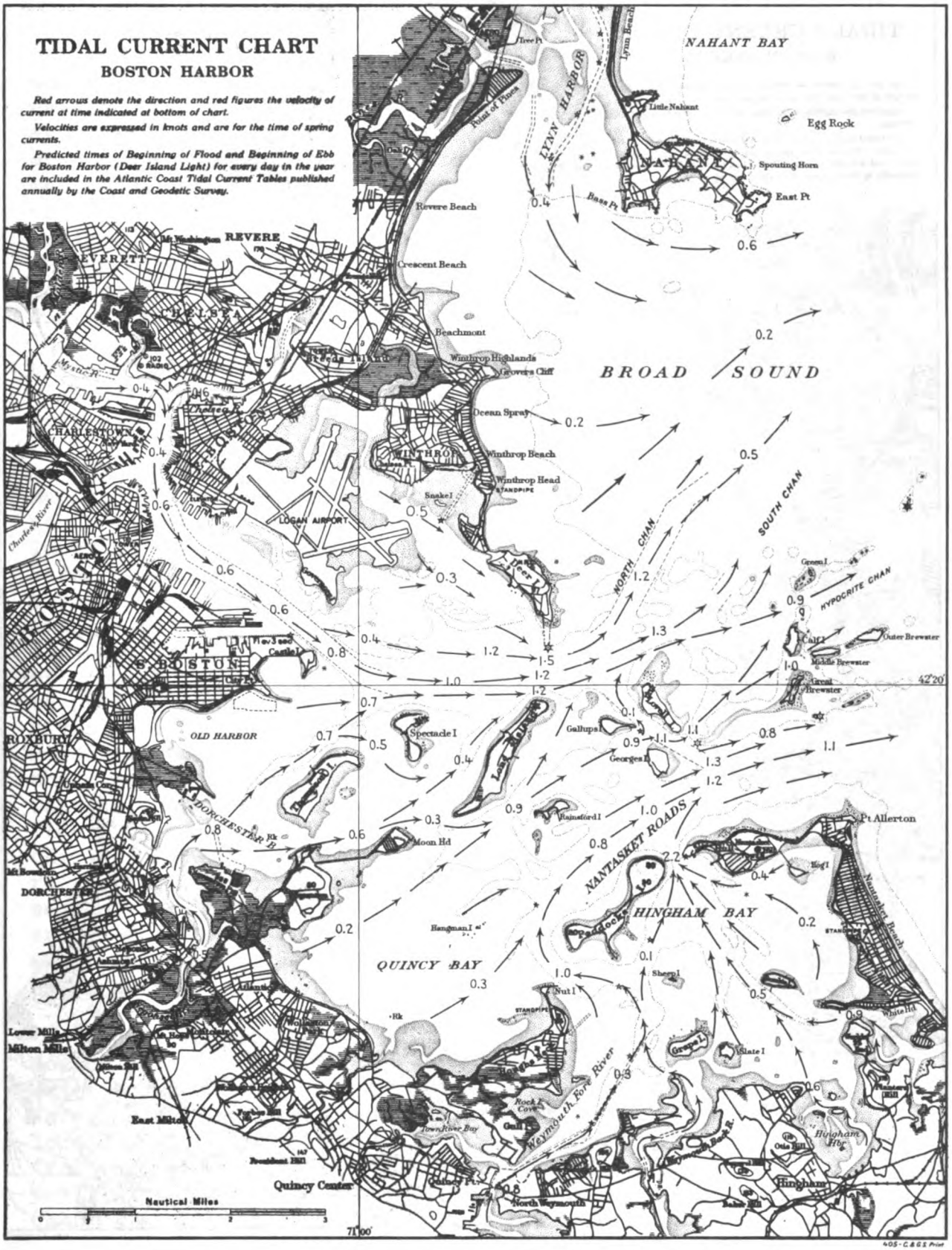

TWO HOURS AFTER BEGINNING OF EBB AT DEER ISLAND LIGHT

(2 hours after high water at Boston)

Figure 14

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FOUR HOURS AFTER BEGINNING OF EBB AT DEER ISLAND LIGHT

(4 hours after high water at Boston)

Figure 15

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mouths of tributaries, salinity values in the harbor are greater than 25 parts per thousand during periods of low precipitation. The relatively small freshwater discharge along with other hydrological characteristics prevents the development of a salt wedge water mass, allowing the formation of a vertically mixed type of estuary having more affinities with embayments than estuaries and aquatic life that is marine rather than estuarine. All reaches of the Boston Harbor and most regions of its tributaries are polluted with large quantities of suspended sewage waste particles. Abnormally large concentrations of ammonia, nitrogen and soluble phosphorus, and extensive deposits of decayed organic metter and oily residues from domestic and industrial wastes also exist in most of the harbor and associated rivers.

The Mystic River originates at lower Mystic Lake in Medford and Arlington, Massachusetts, and follows a generally southeastern course for about 7 miles to its mouth at Boston Inner Harbor. The lower 5 miles of the river, below the Amelia Earhart Dam, are influenced by the tide. As shown in Figures 10 through 15, the tidal flow both upstream and downstream from the LNG facility does not exceed 0.6 knots. The drainage area of the Mystic River is about 65 square miles. The region of the Mystic River near the LNG import site is considered to be part of the coastal waters in the Boston Harbor Basin. The Division of Water Pollution Control of the Massachusetts Water Resources Commission has placed this river in Class SC of the classification system designated for coastal and marine waters, that is, those subject to the rise and fall of the tide. (See Figure 16.) This SC classification indicates that the water quality is suitable for aesthetic enjoyment, recreational boating, industrial cooling and process uses, and contains suitable habitat for wildlife and common food and game fishes indigenous to the region. Table 6 lists the water quality criteria for all coastal and marine waters in Massachusetts.

Chemical and biological surveys of the Mystic River and Boston Harbor were conducted in 1967 by the Massachusetts Water Resources Commission and in 1968 by the then-Federal Water Pollution Control Administration. At a sampling station located on the Mystic River approximately 2½ miles upstream from the terminal (Site A on Figure 16), the only bottom dwelling animals were found to be phantom midge larvae (family Chaoborinae), with a density of 16 per square foot.

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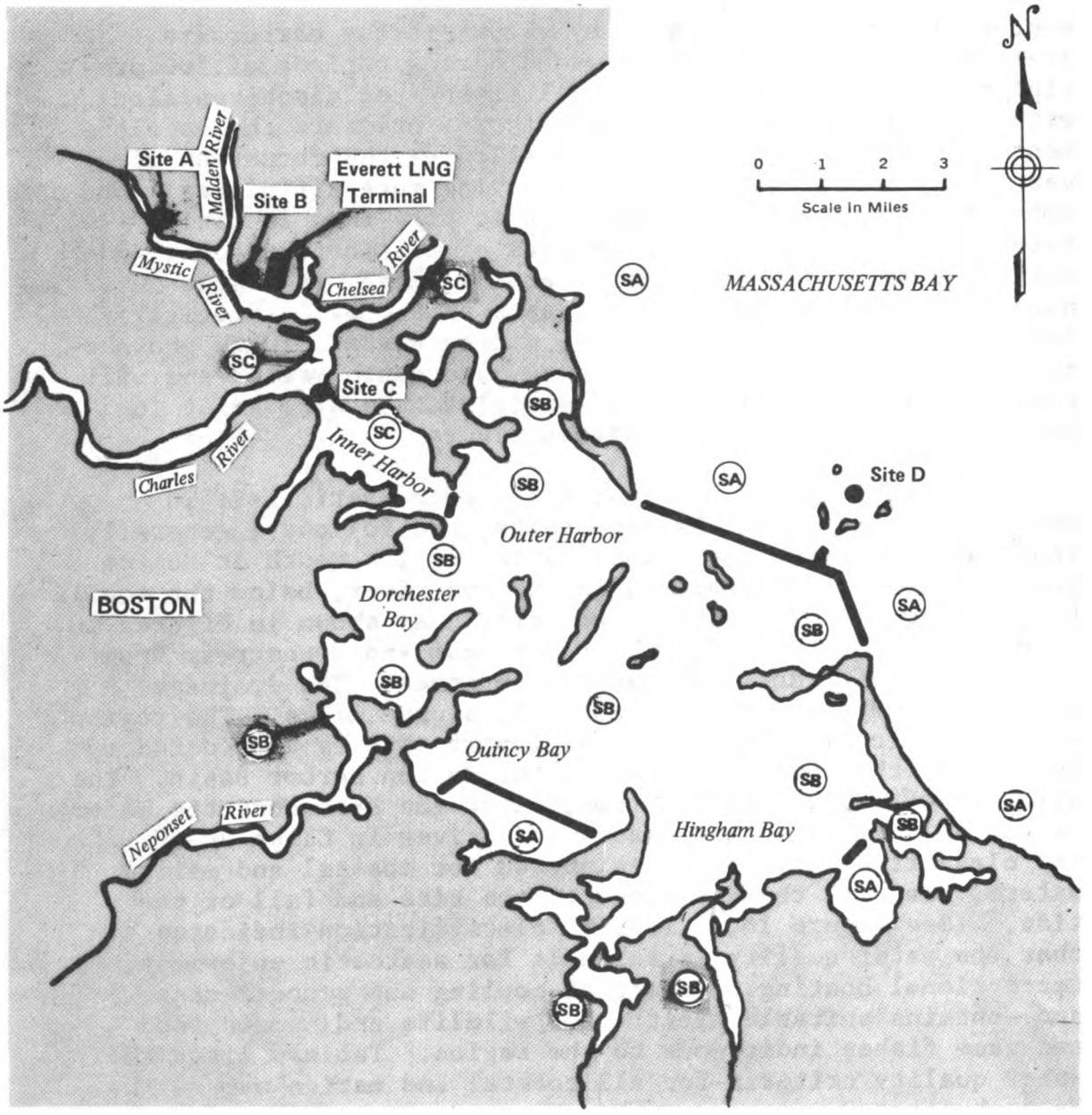

LEGEND

Indicates Change of Classification
Water Quality Standards
Sampling Stations Mentioned in Text

BOSTON HARBOR WATER QUALITY

Figure 16

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TABLE 6

COMMONWEALTH OF MASSACHUSETTS
WATER RESOURCES COMMISSION
DIVISION OF WATER POLLUTION CONTROL
WATER QUALITY CRITERIA
FOR COASTAL AND MARINE WATERS

Item	SA	SB	SC
1. Dissolved oxygen	Not less than 6.5 mg/l at any time.	Not less than 5.0 mg/l at any time.	Not less than than 5 mg/l during at least 16 hours of any 24-hour period nor less than 3 mg/l at any time.
2. Sludge deposits, solid refuse, floating solids, oils, grease, scum	None allowable	None allowable	None except that amount that may result from the discharge from a waste treatment facility providing appropriate treatment.
3. Color and turbidity	None in such concentrations that will impair any usages specifically assigned to this class.	None in such concentrations that would impair any usages specifically assigned to this class.	None in such concentrations that would impair any usages specifically assigned to this class.
4. Coliform bacteria per 100 ml	Not to exceed a median value of 70 and not more than 10% of the samples shall ordinarily exceed 230 during any monthly sampling period.	Not to exceed a median value of 700 and not more than 2300 in more than 10% of the samples during any monthly sampling period.	None in such concentrations that would impair any usages specifically assigned to this class.

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TABLE 6 (Continued)

Item	SA	SB	SC
5. Taste and odor	None allowable	None in such concentrations that would impair any usages specifically assigned to this class and none that would cause taste and odor in edible fish or shellfish.	None in such concentrations that would impair any usages specifically assigned to this class and none that would cause taste and odor in edible fish or shellfish.
6. pH	6.8 - 8.5	6.8 - 8.5	6.5 - 8.5
7. Allowable temperature increase	None except where the increase will not exceed the recommended limits on the most sensitive water use.	None except where the increase will not exceed the recommended limits on the most sensitive water use.	None except where the increase will not exceed the recommended limits on the most sensitive water use.
8. Chemical constituents	None in concentrations or combinations which would be harmful to human, animal, or aquatic life or which would make the waters unsafe or unsuitable for fish or shellfish or their propagation, impair the palatability of same, or impair the waters for any other uses.	None in concentrations or combinations which would be harmful to human, animal or aquatic life or which would make the waters unsafe or unsuitable for fish or shellfish or their propagation, impair the palatability of same, or impair the water for any other usage.	None in concentrations or combinations which would be harmful to human, animal or aquatic life or which would make the waters unsafe or unsuitable for fish or shellfish or their propagation, impair the palatability of same, or impair the water for any other usage.

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TABLE 6 (Continued)

Item	SA	SB	SC
9. Radioactivity	None in concentrations or combinations which would be harmful to human, animal, or aquatic life for the designated water use. None in such concentrations which would result in radio-nuclide concentrations in aquatic life which exceed the recommended limits for consumption by humans.	None in concentrations or combinations which would be harmful to human, animal, or aquatic life for the appropriate water use. None in such concentrations which would result in radio-nuclide concentrations in aquatic life which exceed the recommended limits for consumption by humans.	None in such concentrations which would be harmful to human, animal or aquatic life for the designated water use. None in such concentration which would result in radio-nuclide concentrations in aquatic life which exceed the recommended limits for consumption by humans.
10. Total phosphate	Not to exceed an average of 0.07 mg/l as P during any monthly sampling period.	Not to exceed an average of 0.07 mg/l as P during any monthly sampling period.	Not to exceed an average of 0.07 mg/l as P during any monthly sampling period.
11. Ammonia	Not to exceed an average 0.2 mg/l as N during any monthly sampling period.	Not to exceed an average of 0.2 mg/l as N during any monthly sampling period.	Not to exceed an average of 1.0 mg/l as N during any monthly sampling period.

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This locality is above the saline reaches of the Mystic River thus precluding development of saltwater species. Substantial quantities of oily residues were observed in the black sludge that covered the river bottom. If not severely polluted at this locality, the Mystic River benthos would normally support additional types of bottom animals such as sludgeworms, midge larvae, and polychaete worms. The phytoplankton density in the surface waters was high, exceeding 40 parts per million, or 29,000 cells per milliliter.

Approaching the Boston Harbor, the Mystic River becomes saline, supporting pollution-tolerant polychaete worms, the only bottom-dwelling animals found, in densities in excess of 200 per square foot, indicating excessive nutrient enrichment. Table 7 is a summary of field data collected at a sampling station approximately 1 mile upstream from the Everett import site (Site B on Figure 16). According to the Massachusetts water quality standards in Table 6, this portion of the Mystic River exceeds the maximum concentrations of total phosphate at 0.07 mg/l and ammonia at 1.0 mg/l.

The confluence of the Chelsea, Mystic, and Charles Rivers forms a waterway known as Boston Inner Harbor which begins approximately 1 mile downstream from the Everett LNG terminal site. (See Figure 16.) Tidal currents in Boston Inner Harbor are strong. They would be expected to displace the wastes entering the area from the above tributaries except that additional wastes entering the Inner Harbor exceed the waste dispersal capacity of the currents. As a result, some wastes from local and tributary sources are deposited here as sludge. The benthic regions of the Inner Harbor were found to be covered with oily sludge. The predominant aquatic life consisted of polychaete worms, occurring at a density of 964 worms per square foot at Site C in Figure 16; this is indicative of excessive bottom enrichment. It is likely that harbor dredging for channel maintenance disturbed these bottom deposits to the extent that higher polychaete populations could not exist. At this site the average concentration of ammonia nitrogen was 0.20 mg/l,which met the state standards for Class SC. The average concentration of soluble phosphorus was 0.07mg/l, equaling the maximum allowable concentration.

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TABLE 7

SUMMARY OF FIELD DATA - SITE B

MYSTIC RIVER

SECTION A: TEMPERATURE AND DISSOLVED OXYGEN

Mean Time	Date	Temp. °C	D.O. mg/l	Date	Temp. °C	D.O. mg/l	Date	Temp. °C	D.O. mg/l	Date	Temp. °C	D.O. mg/l	Temp. °C Max.	Temp. °C Min.	Temp. °C Avg.	D.O. mg/l Max.	D.O. mg/l Min.	D.O. mg/l Avg.
0815	8-29	22	7.5	8-31	23	5.8	9-12	16	7.4	9-14	17	8.6	23	16	20	8.6	5.8	7.3
1215		23	9.8		23	6.6		18	8.7		19	9.7	23	18	21	9.8	6.6	8.7
1615		23	12.9		23	8.5		11	9.3		20	10.6	23	11	19	12.9	8.5	10.3
2015		23	10.5		21	7.6		11	17.2		20	10.8	23	11	19	17.2	7.6	11.5

SECTION B: COMPOSITE OF SAMPLES FROM 8, 12, 16, AND 20 HOURS

* Geometric Mean

Date	B.O.D. mg/l 2day	5day	7day	Susp. Solids mg/l	pH	Alkalinity mg/l	Spec. Cond.	Nitrogen mg/l Org.	NH_3	NO_2	NO_3	Phosphates mg/l Total	Ortho	Color Units	Turb. Units	Chloride	Coliform Bacteria per 100 ml
8-29	4.2	7.9	10.0	8	8.0	83	8000	3.4	0.23	0.078	0.2	0.18	0.03	50	25	2800	8,000
8-31	6.1	7.9	8.9		7.7	85						0.20	0.03				60,000
9-12	4.0	7.0	8.8	21	7.9	73	8000	2.0	0.30	0.050	0.2	0.22	0.04	70	30	2600	3,200
9-14	3.8	5.2	6.6		7.6	83						0.20	0.02				4,800
MAX	6.1	7.9	10.0	21	8.0	85		3.4	0.30	0.078		0.22	0.04	70	30	2800	60,000
MIN	3.8	5.2	6.6	8	7.6	73		2.0	0.23	0.050		0.18	0.02	50	25	2600	3,200
AVG	4.5	7.0	8.6	15	7.8	81	8000	2.7	0.26	0.064	0.2	0.20	0.03	60	28	2700	*9,220

Source: Mystic River Study 1967, Massachusetts Water Resources Commission

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Phytoplankton numbers were lower than those in the Mystic River, but still at very dense concentrations. At high tide, there was an average of 2,500 phytoplankton per milliliter near the surface, with a volume of 3.27 parts per million. At low tide, these figures were 4,000 and 0.88, respectively.

Other regions of Boston Harbor were found to be similarly polluted toagreater or lesser extent. About 66 percent of the harbor had excessive phytoplankton populations and approximately 30 percent was grossly polluted, denoted by polychaete densities of 1,000 or more per square foot. Clean water, characterized by associated animals such as chitons, sponges, starfish, shrimp, brittle-stars, and crabs, was found away from the harbor in Massachusetts Bay (Site D, Figure 16). The bay bottom in this area consisted of clay, clean sand, rocks, and rubble and supported a variety of attached algae.

Saltwater fishery resources in the Massachusetts Bay area include striped bass, cod, pollock, mackerel, flounder, and tuna. These would not be found in the heavily polluted harbor areas. Shellfish of economic value in salt and brackish water include lobsters, soft-shelled clams, bay scallops, oysters, rock crabs, and quahogs. Pollution of coastal waters near Boston caused the condemnation of many clam flats along the coastline. In other cases, clams may be harvested but must be treated in purification plants before being put on the market. In the past, the discharge of phenolic substances in industrial wastes caused destruction of captive lobsters in Boston Harbor.

The land for the terminal site is located in the temperate deciduous forest biome. Dense stands of timber at one time covered practically all of the land of the Massachusetts coastal area, with the principal forest types consisting of oak-pine, white pine, oak-hickory, northern hardwood and aspen-paper birch. The area around the terminal has been almost totally developed for industrial and commercial purposes. Field inspection of the site revealed a virtual lack of any vegetation and associated fauna, although house sparrows and pigeons could inhabit some of the buildings within the terminal area. The only biotic community in the vicinity of the Everett facilities is a marshy region, about 15 acres in size, situated approximately 1,000 feet northeast of the LNG storage site.

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e. Climate

The climate of the Everett-Boston region is characteristic of New England: temperate, changeable, and marked by four distinct seasons. The weather is variable, characterized by frequent but short periods of heavy precipitation. The area lies in the path of "prevailing westerlies", where winds are predominantly northwesterly in winter and southwesterly in summer. The mean annual wind speed is 11.2 miles per hour, with an average of 12.4 miles per hour in January and 9.6 miles per hour in July. While the wind seldom exceeds 60 miles per hour, gusts up to 100 miles per hour have been recorded during tropical storms. The project region is exposed to occasional coastal storms, some of which are of tropical origin, that travel up the Atlantic seaboard. These storms, locally known as northeasterns, are heavily laden with moisture from the sea. The effects of mountains on the climate are limited due to the relatively small extremes of elevation within the area.

The average annual temperature of the Boston-Everett area is 51.4°F. Average monthly temperatures vary widely throughout the year, from between 23°F and 36.8°F in January to between 65.4°F and 81.9°F in July. The average annual precipitation in the area is 42.77 inches, distributed rather evenly throughout the year. The most rainfall ever recorded in any 24-hour period was 8.4 inches. An average of 42.2 inches of snow falls each year around Everett, with the greatest snow accumulation expected in middle or late February. There is an average of approximately 23 days of heavy fog and 19 thunderstorms each year. An average of four tornadoes occur annually in Massachusetts.

Hurricanes occasionally take place off the coast of Massachusetts, usually from June through October. Meteorological records indicate that the frequency per 100 years of such tropical storms is approximately 4.8 for storms causing moderate tidal flooding and 42.9 for storms which threatened the area but caused minor or no tidal flooding. The Great New England Hurricane of September 21, 1938, caused tidal flooding of over 14 feet above mean sea level along the Massachusetts coastline, with property damage estimated at $65,000,000 and a loss of 187 lives. Northeasters are far

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more frequent than hurricanes in the Boston-Everett area and can occur at any time of the year, although they are more numerous in the late fall, winter, and early spring. From 1870 to 1945, there were 160 storms with continuous winds of 32 miles per hour or greater. A storm in January of 1961 caused $6,800,000 in damages due to tidal flooding in the Boston area. The record tidal level in Boston Harbor is 15.4 feet above mean low water level (10.5 feet above mean sea level).

f. Air and Noise Quality

The air quality for the terminal site in Everett is typical of a metropolitan region containing heavy and light industry and a large amount of motor vehicle traffic. Pollutants such as sulfur dioxide (SO_2), nitrogen dioxide (NO_2), carbon monoxide (CO), hydrocarbons, photochemical oxidants, and suspended particulates are present in the atmosphere over the site area.

To provide a general quantitative description of the air quality near the LNG terminal, data from several monitoring stations within the Air Quality Control Region (AQCR) covering the vicinity of the DOMAC site are shown in Table 8. The locations of the monitoring stations are shown in Figure 17.

The national primary and secondary standards are presented along with Massachusetts air quality goals in Table 9. Comparison of the air quality measurements presented in Table 8 with the standards of Table 9 shows that the particulate level at four of the eight stations exceeds the primary limits of both the state and Federal governments. Three more of the remaining stations match or exceed the national secondary standards. In addition, although Massachusetts has not adopted limits, six of the stations exceed the national primary standards set for NO_2. All of the measuring sites indicate SO_2 levels well below the limits of both the state and primary Federal standards, with only one site in excess of the secondary limits. Although actual measurements are not available for the DOMAC site, interpolation of data from the surrounding measuring stations indicates that excessive levels of particulates and NO_2 at the LNG facility would be expected.

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1972 AIR QUALITY VALUES FOR

SITES IN THE VICINITY OF EVERETT, MASS.

TABLE 8

Site	Pollutant	Annual Average	Highest 24-Hour Value	Date (Month-Day)	Second Highest 24-Hour Value	Date (Month-Day)
Boston						
JFK Building	TSP ($\mu g/m^3$)	80	226	7-8	130	11-24
	SO_2 ($\mu g/m^3$)	13	80	11-24	34	10-30
	NO_2 ($\mu g/m^3$)	132	353	8-20	253	8-25
Boston						
Kenmore Square						
590 Commonwealth Ave	TSP ($\mu g/m^3$)	108	352	1-10	325	3-24
Trailer	SO_2 ($\mu g/m^3$)	67	257	1-22	220	1-11
	NO_2 ($\mu g/m^3$)	156	406	4-29	440	5-18
East Boston						
68 Central Square	TSP ($\mu g/m^3$)	62	159	3-28	142	1-10
	SO_2 ($\mu g/m^3$)	34	136	11-17	121	11-29
	NO_2 ($\mu g/m^3$)	124	596	5-21	301	6-20
Cambridge						
Devdia Street	TSP ($\mu g/m^3$)	44	138	8-25	107	1-10
Harvard Herbaria	SO_2 ($\mu g/m^3$)	20	107	1-10	73	1-22
	NO_2 ($\mu g/m^3$)	91	239	1-10	218	8-25
Cambridge						
Museum of Science	TSP ($\mu g/m^3$) (5 mos.)	91	292	2-23	173	1-14
Trailer	SO_2 ($\mu g/m^3$)	54	149	2-1	128	1-18
	NO_2 ($\mu g/m^3$)	111	265	1-13	207	1-20,21 & 22
Medford Fire						
Headquarters	TSP ($\mu g/m^3$)	60	148	1-10	134	8-25
100-120 Main	SO_2 ($\mu g/m^3$)	21	97	6-20	79	1-22
Street	NO_2 ($\mu g/m^3$)	96	197	1-4	177	9-12
Medford						
Wellington Circle	TSP ($\mu g/m^3$)	89	202	11-17	198	12-29
Trailer	SO_2 ($\mu g/m^3$)	45	152	11-30	147	10-28
	NO_2 ($\mu g/m^3$)	146	320	7-21	280	7-12 & 8-3
Revere						
368 Garfield Street	TSP ($\mu g/m^3$)	56	157	6-14	137	5-3
	SO_2 ($\mu g/m^3$)	38	207	6-8	191	2-3
	NO_2 ($\mu g/m^3$)	113	271	1-28	241	5-27

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TABLE 9

COMPARISON OF NATIONAL PRIMARY AND SECONDARY STANDARDS AND MASSACHUSETTS AIR QUALITY STANDARDS

Pollutant	National Primary Standard	National Secondary Standard	State of Mass. Standard
Sulfur Dioxide	80 ug/M^3 (annual arithmetic mean)	60 ug/M^3 (annual arithmetic mean)	73 ug/M^3 (annual arithmetic mean)
		1300 ug/M^3 (3-hr maximum)	800 ug/M^3 (1-hr maximum)
	365 ug/M^3 (24-hr maximum)	260 ug/M^3 (24-hr maximum)	300 ug/M^3 (24-hr maximum)
Particulates	75 ug/M^3 (annual geometric mean)	60 ug/M^3 (annual geometric mean)	75 ug/M^3 (annual geometric mean)
	260 ug/M^3 (24-hr maximum)	150 ug/M^3 (24-hr maximum)	180 ug/M^3 (24-hr maximum)
Carbon Monoxide	10 mg/M^3 (8-hr maximum average)	10 mg/M^3 (8-hr maximum average)	-
	40 mg/M^3 (1-hr maximum average)	40 mg/M^3 (1-hr maximum average)	
Total Oxidants	160 ug/M^3 (1-hr maximum average)	160 ug/M^3 (1-hr maximum average)	-
Hydrocarbons	160 ug/M^3 (3-hr maximum average)	160 ug/M^3 (3-hr maximum average)	-
Nitrogen Dioxide	100 ug/M^3 (annual arithmetic mean)	100 ug/M^3 (annual arithmetic mean)	-

* Standard conditions for measurements are established at 25°C, 1 atm pressure.

Source: Environmental Protection Agency, Boston, Massachusetts.

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LOCATIONS OF
AIR SAMPLING SITES
Figure 17

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Noise levels in the vicinity of the LNG terminal are typical of those in an industrialized area. Exact decibel readings are not available for the region in and around the terminal; however, nearby industrial noise is prevalent due to ship, train, truck and manufacturing activities. At present, Massachusetts has no noise quality standards of a quantitative nature; however, the state does investigate community complaints of noise levels which could be classified as a nuisance. The criteria used by the state in these investigations are: (1) that increases of 10 dB(A) broadband above background noise levels at the owner's property line are not permitted, and (2) that increases of puretone characteristics are not permitted at all.

g. Archaeological, Historical, and Recreational

The National Register of Historic Places maintained by the Secretary of the Interior contains 56 entries for Boston, three for Medford, and one for Chelsea. Historical sites and areas near the LNG shipping route include the Old North Church, Paul Revere House, Old State House, Faneuil Hall, and "U.S.S. Constitution." The Bunker Hill Battlefield is situated approximately 1 mile south of the Everett LNG terminal.

Figure 18 shows various park and recreational areas in the general area around the LNG terminal and shipping route. The Vietnam Veterans Memorial Pool in Chelsea is located about 1¼ miles northeast of the terminal. Foss Park, in Sommerville, 1½ miles east of the terminal, contains a swimming pool and recreation field. The Emmons-Horrigan ice skating rink in Boston is about 1½ miles south of the terminal. Three playgrounds owned by the city of Everett are located within about 2,000 feet of the DOMAC LNG facilities, comprising a total area of about 3 acres. The Sacromon-Kelvin Street Playground project, approximately one-half mile northwest of the proposed facilities, is part of a park renovation project to replace wornout equipment and provide new facilities, such as swimming pools. The land bordering the Mystic River west of the confluence with the Malden River is classified as the Mystic Recreation Area, now under design by the Metropolitan District Commission. It will offer a wide range of recreational facilities, including boating, skating, picnicking, and hiking. Presently, five public and private boating facilities exist along the river.

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PARKS AND RECREATION AREAS IN THE BOSTON HARBOR AREA

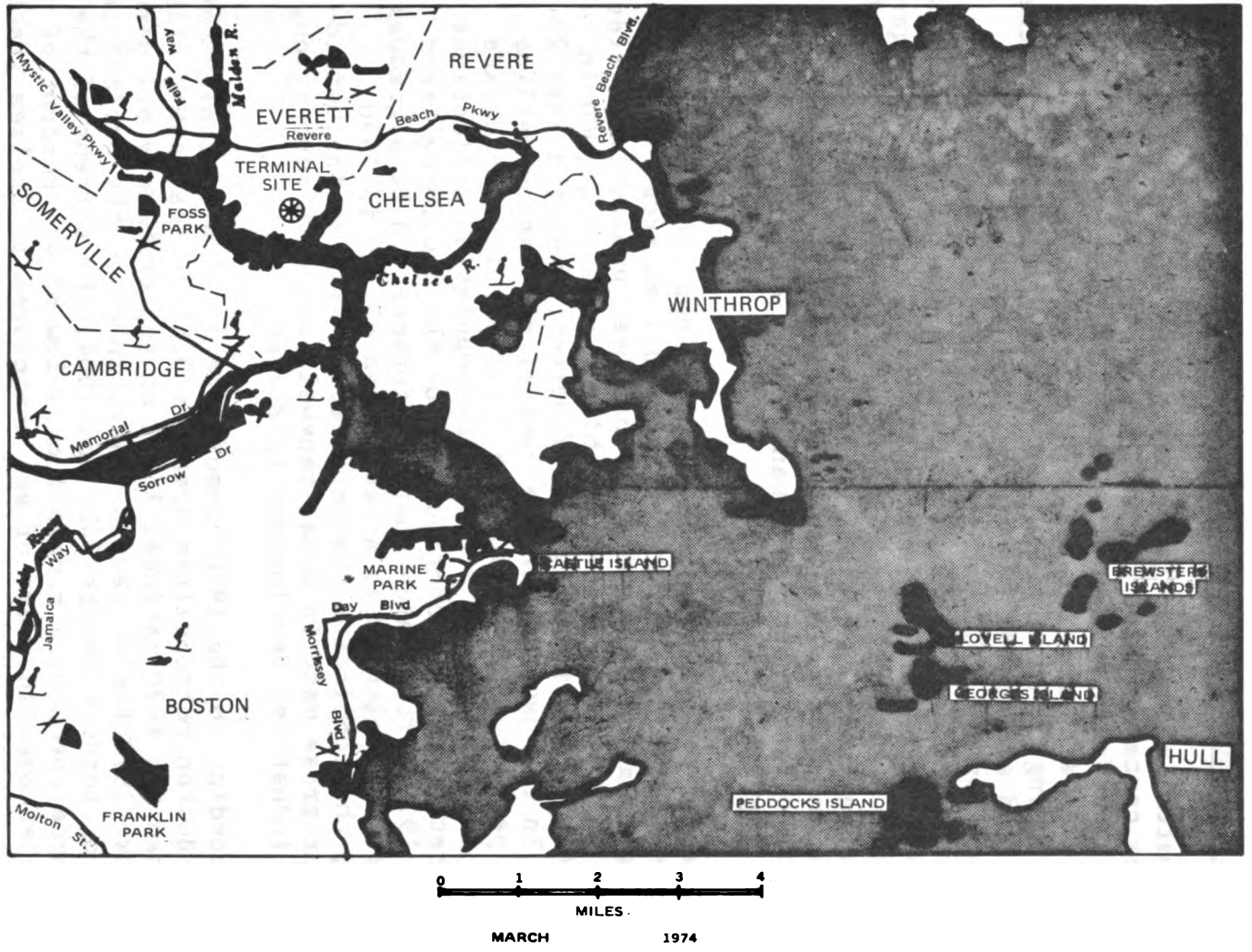

Figure 18

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h. Socioeconomic Considerations - Metropolitan Area

Boston, Massachusetts, is one of the oldest urban and shipping centers in the United States. Its economy and growth have followed a three-phase development pattern, starting as a commercial-shipping center, converting to a manufacturing-based economy, and finally expanding into the diversified economy it has today. Population growth and urban development followed the economic development of the city until the end of the manufacturing phase, when population and development of inner city areas like Everett began to decline as industry and some of the population relocated in suburban areas. However, recent years have seen an increase in new development and renovation in some of the areas of Boston Harbor, accompanied by a decrease in the rate of population decline.

Everett, Massachusetts, is located near the more densely populated center of the Boston metropolitan area and had a 1970 population of 42,485. It has been undergoing a steady decline in population since reaching a peak of 46,000 in 1950, at a cumulative rate of 7.7 percent over the last 20 years. In the past decade the rate of population decline was 2.5 percent as compared to 5.2 percent for the decade between 1950 and 1960. Preliminary population projections for Everett predict a continuation of the declining trend through 1975, after which there is forecast to be a gradual increase in population to an estimated 43,000 in 1990. However, the population characteristics will be influenced by the progress made in urban renewal, downtown renovation, and new industrial development in Boston.

According to the 1970 census, the level of unemployment for the Boston metropolitan area was 3.5 percent, substantially lower than the 1970 national level of approximately 6.1 percent. In the two 1970 Boston census tracts in which the project is located or borders, Tracts 3427 and 1604, the percent of the labor force unemployed ranges from a low of 4.1 percent of the females over 16 years of age unemployed in Chelsea Tract 1604 to a high of 8.1 percent of the male workforce unemployed in Everett Tract 3427. (See Table 10.) Median income for the two tracts is $9,392 for Tract 3427 and $7,089 for Tract 1604, and the percentages of families below the poverty level

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TABLE 10

Comparative Income and Employment Data
Boston, Massachusetts Standard Metropolitan
Survey Area (SMSA)*

Tract No.	Total Population	Total Employed	% Unemployed Male	% Unemployed Female	Medium Income	% Families Below Poverty Level
Everett (all tracts)	42,485	17,889	4.3	5.1	10,086	5.8
3427 (Everett)	1,690	618	8.1	7.3	9,392	4.4
1604 (Chelsea)	4,049	1,499	4.4	4.1	7,089	18.3

* Bureau of Census, 1970, General Social and Economic Characteristics, Boston, Massachusetts, U. S. Department of Commerce.

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are 4.4 percent and 18.3 percent, respectively. The city of Everett as a whole has a total industrial employment of 17,889, as shown in Table 11. Of this total employment, manufacturing employs approximately 28.1 percent, retail trade employs 15.3 percent, finance-insurance-real estate employs 8.7 percent, public administration 8 percent, and construction employs 5.8 percent. Employment data for the individual tracts can be found in Table 11.

The 1970 census statistics indicate that the recent socioeconomic trends in the Everett area will continue with little change, although projects involving urban renewal and renovation of the existing industrial and port districts could be initiated. Several proposals calling for the renovation of harbor facilities have been submitted before the Port of Boston Authority in recent years and could spur new industrial development in the general harbor area. Initiation of renewal-development projects would affect local employment patterns and possibly create a demand for additional housing.

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TABLE 11

Employment by Industry, 1970

Industry	Everett Mass. No. of Employees	Everett Mass. % of Employment	Tract 3427 No. of Employees	Tract 3427 % of Employment	Tract 1604 No. of Employees	Tract 1604 % of Employment
Manufacturing	5,036	28.2%	210	34%	486	32.5%
Retail Trade	2,742	15.3%	107	17.3%	244	16.3%
Wholesale Trade	-	-	58	9.4%	177	11.8%
Public Administration	1429	8%	-		90	6.0%
Finance-Insurance-Real Estate	1,562	8.7%	-		83	5.5%
Construction	1,029	5.7%	42	6.8%	85	5.6%
Other	6,091	34.1%	201	32.5	334	22.3%
Total Industrial Employment	17,889	100	618	100	1499	100

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3. ENVIRONMENTAL IMPACT OF THE PROPOSED ACTION

a. Land Use

The DOMAC terminal is currently zoned for medium to heavy industry, and the construction and operation of these facilities has not, up to this time, conflicted with the uses of the surrounding area. With the projected number of LNG ship deliveries at 14 per year plus an additional 16 deliveries over the 18-month period of Docket CP76-9, ship traffic through the Boston Harbor and up the Mystic River would be affected by this incremental increase. Local highway traffic levels would increase with the operation of the project, as it would be affected by loading and transport of LNG by tank truck, which the applicant estimates could be up to 50 or 60 trucks per day on days of peak demand.

It is possible that continued operation of the LNG terminal facilities would influence the land use and development patterns of adjacent properties and surrounding commercial and industrial areas. Individuals and concerns that view the complex as a safety hazard could decide to relocate existing or planned industrial/commercial/residential uses. Similarly, interests attracted by the potential supply of gas could be attracted to the area, further changing land use. The extent of this impact would depend on the safety and accident record of the facilities. An unusual accident such as an LNG spill or fire could damage residential and industrial areas. Short-term disruptions in normal land use, such as the evacuation of nearby areas and the suspension of local highway and shipping traffic, would most likely result from an accident involving large quantities of gas. Damage to surrounding residential and industrial properties could cause short-term interruption of use, replacement of damaged facilities, and further restrictions of land and water use for either the LNG facility or the surrounding area. Successful and safe operation of the terminal facilities could lead to increased industrial development of a similar sort on the Mystic River, further improvements on the shipping channel, and the installation of additional LNG terminal facilities.

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b. Physiography, Topography and Geology

Continued operation of the LNG terminal facilities would have little impact on the geological environment. Minor compaction and expansion of the soil beneath the LNG tanks would take place as the tanks were loaded and unloaded, but the integrity of the foundation would not be adversely affected. The Boston area is considered to be in Zone 3 of seismic risk. However, the significance of this classification should not be over-emphasized until the USGS has completed its reevaluation of the national seismic risk map which is presently used as the basis for seismic design in the Uniform Building Code. LNG deliveries would have no effect on the geological environment.

Unusual accidents, such as an LNG spill or fire, would have some impact on the geologic and physiographic environment. An LNG spill would temporarily freeze any topsoil covered by the LNG. The extent of the impact would depend on the water content of the soil involved, the downward penetration of LNG into the soil, and the time period between the spill and its evaporation into the atmosphere. Any alteration of soil properties would be temporary. Some soil and groundwater contamination could occur in the case of either an LNG spill or fire. These impacts would be affected by the measures taken and chemicals used to control a spill or fire.

c. Aquatic and Terrestrial

Water used for cooling the compressors at the DOMAC terminal would be recirculated, thereby avoiding the discharge of heated water to the Mystic River. The water bath vaporizers would also recirculate their water except for an overflow volume not expected to exceed 1,500 gallons per day at 80°F. This rate is slightly over one gallon per minute and would have a negligible effect on the aquatic environment. Sanitary wastes would be put into the municipal sewage system. Storm water runoff to the Mystic River from the diked area of the terminal should average approximately 16,000 gallons per day on an annual basis.

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The dikes are surfaced with crushed rock and an asphaltic compound, which keep the runoff low in sediment. In addition, the diked area is maintained free of debris, keeping it clear of organic matter. These two measures should keep the quality of the storm water runoff higher than the water quality of the Mystic River.

No solid wastes or polluted effluents would be discharged from the LNG tankers after entering the harbor or while moored at the unloading terminal. During this period, sanitary sewage would be contained onboard. Should an extended stay of a vessel become necessary, arrangements would be made with a licensed contractor to off-load accumulated liquid and solid wastes. Vessels may take on fuel oil after unloading at the Everett terminal, although such fuel facilities would not be available at the terminal. The refueling operations would be in accordance with applicable regulations, including equipment for the prevention of oil spills. The terminal would have access to 200 feet of floating oil-spill boom.

Dredging operations during the construction of the Everett terminal caused a temporary degradation of water quality in the vicinity of the Mystic River. The dredging stirred up sediments which consequently increased the turbidity of the water for several hours and temporarily reduced the photosynthetic activity, as well as microbial decomposition of suspended organic material resulting in lower dissolved oxygen concentrations. Zooplankton were destroyed or placed under stress as the dissolved oxygen level was reduced. As mentioned in Section 2(d), the water and the bottom sediment in the vicinity of the terminal have been severely polluted. Hydrocarbon and heavy metal contaminants of the bottom sediment which were stirred up by dredging could have been incorporated into the aquatic ecosystem due to ingestion by suspension-feeding organisms until these contaminants resettled to the river bottom. Most of the sediments probably settled out within several hundred yards of the dredging area. The berthing and wharf areas and the turning basin would have to be periodically dredged to maintain the present bottom depth, and similar impacts to the aquatic ecosystem as mentioned above would be expected to occur.

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Little impact upon the terrestrial environment would be anticipated with continued operation of the LNG facilities. An LNG spill or fire at the Everett site would have a minimal terrestrial impact as the terminal is situated in an industrialized region with few plant or animal habitats.

Because of its volatility at ordinary temperatures, the Environmental Protection Agency and the Coast Guard do not classify LNG as a hazardous polluting substance that affects water quality. Spills of large quantities of LNG on water are judged to have no long-term effects on aquatic life or waterfowl such as those associated with large oil spills. Also, there has been no evidence of fish kills due to LNG spills. Minor effects from an LNG spill on water may cause localized biotic disturbances if the surface water freezes momentarily. However, no tests on the impact to aquatic biota as a result of LNG spills have been conducted; perhaps the only aquatic life affected would be insects inhabiting the surface of the water. On the other hand, if spills spread into a marsh area or to plants along a shoreline, the low temperature and/or the displacement of air by the LNG vapors could affect animals and birds. Any impact would be limited to the area of the spill, since the LNG quickly evaporates and the vapor cloud rises and dissipates in the wind. For the largest uncontained spills, the total time of impact is less than 1 hour.

d. Climate

The operation of the Everett LNG terminal has virtually no impact on the climate of the project area. Unusual accidents, such as an LNG spill or fire, could temporarily affect local atmospheric conditions. An LNG spill would cause a highly localized reduction in air temperature as it evaporated, or could result in a similarly localized temperature increase if ignited. The duration and degree of such impacts would depend on the existing meteorological conditions at the time that the accident occurred, as well as upon the magnitude of the spill.

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It is possible that abnormally harsh climatic conditions could damage the LNG facilities to the extent of causing a release of LNG. As mentioned earlier, hurricanes and northeasters have occasionally passed through the Boston area generating high winds and tidal flood surges. Flood stages of the Mystic River would not be expected to reach the LNG storage tanks and vaporizer equipment because they are situated far enough from the river. However, objects and debris being blown by high winds could damage the facilities. The tanks themselves are designed to withstand a 124-mile per hour wind load on the tanks. The dockside facilities would be the most susceptible to damage from flooding and could be partially covered by water during such a period. Records from storms indicate that the maximum tidal height in Boston was 10.5 feet above mean sea level.

e. Air and Noise Quality

The terminal operations have a minor impact on the air and noise quality in the vicinity of the facility. Gaseous emissions are produced from the onsite compressors and water bath vaporizers; however, since these units use natural gas as a fuel, the impact on localized air quality is considered to be minimal. Emissions are generated from the flare stack; however, these emissions consist of natural gas or its combustion products and pose a minor impact on existing air quality. Noise emissions from the compressors are also considered to have a minor impact on the noise quality of the area due to the industrialized nature of the terminal vicinity. Truck transportation of LNG from the terminal is not expected to cause a significant impact on the air and noise quality associated with the terminal area. It is estimated that from 50 to 60 trucks could be loaded per day if the entire project becomes fully operational.

Shipping operations are not expected to result in a significant impact to the air and noise quality in the vicinity of the proposed project. Tanker deliveries are estimated to be 14 per year of the twenty year contract and up to 16 over the life of the 18-month proposal. LNG venting would not occur during normal operations. In transit, the entire boil-off would be consumed as fuel in

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the ship's boilers. When the ship operates under less power requirements, the boil-off is consumed in the boilers and the excess energy is utilized by condensing the generated steam directly in the main or auxiliary condenser. The ships, while approaching and within United States harbors, use primarily LNG boil-off fuel. When the ship is moored, the boilers utilize Bunker-C fuel oil, along with boil-off flashgas, to generate enough steam to drive onboard generators. Stack emissions are discharged from the ship's stack into the atmosphere. In addition, the blowing of the ship's boiler tubes in part would result in smoke and soot. Noise levels, similar to those of large oceangoing vessels, are increased during the duration of the vessel's entry and departure of the harbor area. The increased noise levels are the result of the operation of the vessel's steam turbines, electrical generators, and ship's whistle.

f. Archaeological, Historical, and Recreational

Continued operation of the proposed project would not result in any impact upon the archaeological, historical, and recreational resources of the project area under normal project operating conditions. In case of an unusual accident such as an LNG-related fire, the recreational facilities close enough to the accident area could be directly affected.

The magnitude of any damage to these facilities would depend on the size and location of such a fire. Heavy smoke from a fire could temporarily restrict the use of the local recreational facilities, depending on the wind direction and the duration of the fire. Under certain meteorological conditions, recreationists in the vicinity of the proposed project areas could be adversely affected both by inhalation of concentrated LNG vapor or the ignition of any large quantities of LNG vapor over recreational facilities.

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g. Socioeconomic Considerations

Continued operation of the Everett terminal would have a minor impact on the socioeconomic structure of the area. The increases in LNG tanker and truck deliveries would generate some additional tax and service revenue for areas along the delivery route, but would not create enough new jobs to put a significant demand on local housing and services. Depending on public sentiment, it is possible that terminal operations could lead to a depreciation of local property values. Continual safe operations should have no detrimental effects, whereas a spillage and/or fire incident could portray a dangerous image which would be reflected in lowered property values.

Socioeconomic costs to the state, county, and municipal governments involved in the event of a major accident could be substantial. An LNG spill or fire could require the assistance of local firefighting, police, and medical facilities, the expense of which would be absorbed in large part by municipal and county governments. Such accidents could also result in property damage and loss of life, and that cost would be borne by DOMAC, individuals, municipalities and industries affected. Any economic costs resulting from such potential accidents would depend to a large degree on the effectiveness of accident prevention safeguards and other safety measures employed by the applicant and associated groups transporting the LNG.

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h. Analysis of Public Safety

When analyzing the impact on the public safety of the LNG import and storage terminal in Everett, Massachusetts, the major concern should be consideration of an LNG spill and the subsequent formation and downwind travel of a potentially ignitible vapor cloud.

Although there is little actual experience with the extent of hazards to the public from the type of LNG import terminal existing in Everett, there are data concerning experiments involving LNG spills, analytical techniques for calculating vapor dispersion, and past experience involving the transportation and storage of other flammable liquids. These data and techniques can be used to analyze the potential hazards associated with LNG terminal operations.

In the following analysis of public safety, the operation of LNG vessels in harbor areas has received the primary emphasis. The rationale is that shipping accidents are the most likely mechanism for large-scale spillage of LNG. Since much of the land in the Boston Harbor area is heavily populated, LNG spills within this area would pose the greatest threat to public safety. A land-based storage tank spill would be limited to the confines of the surrounding dike, thereby limiting the hazards associated with such an unlikely event. Small LNG spills, such as truck leaks or flange or piping breaks, would also create hazardous situations but would be much less severe than those created by large-scale spills.

The marine transportation of LNG within Boston Harbor would pose the greatest threat to public safety if an accident resulted in the spillage of LNG onto the water from a damaged LNG transport vessel. In such a case, the escaping LNG would form a potentially flammable vapor cloud which could endanger the population residing within the dispersion limits of the cloud. The direction of movement and the extent of the vapor cloud would depend on the volume of the LNG spill and the prevailing meteorological conditions at the time.

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In order to calculate the probability and assess the consequences of large-scale LNG spills on water, Scientific Applications Incorporated (SAI), under contract to and with the participation of the FPC staff, conducted an analysis utilizing SAI's computer programs called SLICE and SIGMET and numerous analytical techniques. The substance of the SAI study is as follows:

In conducting the study of LNG spillage probabilities and accident fatalities, a basis for the volumetric size of a large-scale spill needed to be determined. Of considerable importance is a determination of what type of shipping accident could result in a sudden release of large volumes of LNG that would generate an unignited methane vapor cloud. Such an accident would need to be nonexplosive and cause a sudden failure of the ship's internal structures. This type of damage could occur when a tanker strikes a submerged bottom protrusion, is grounded, or is involved in a collision.

Because of the double-hull design of LNG tankers, damage from bottom protrusions sufficient to cause penetration of a cargo tank with subsequent large-scale LNG loss is very unlikely. Encounters with such protrusions are rare, and thus the question of LNG ships striking protrusions remains a very small numerical uncertainty. For flat bottom groundings, the double-hull nature of the ships would permit the outer hull to absorb the frictional loadings without rupture of the LNG tanks. Therefore, grounding on a relatively flat bottom was not considered by SAI or the staff to be a possible mechanism for the release of LNG.

A ship collision with another vessel was considered to be the most likely mechanism for a large-scale LNG release. In conducting this study, SAI analyzed the effects of a 37,500-cubic meter spill from the sudden and complete release of a single ship storage tank and a 75,000-cubic meter spill from two tanks. Physical constraints on maximum vessel speeds and maximum depth of collision penetration renders the possibility of a sudden LNG release of more than two tanks implausible. This is not to imply that the total destruction of a loaded LNG vessel and consequent loss of its entire contents is not possible. But such a catastrophic

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event would require a fire and explosive forces. Such ignition sources would preclude the formation of a hazardous LNG vapor cloud, which is the subject of major concern in these investigations.

The FPC staff and SAI consider the 37,500-cubic meter spill to be the "probable maximum" spill to occur in a large-scale LNG release from ship collision, although it should be recognized that vessels carrying storage tanks with this capacity are not part of the proposed project. The largest single storage tank would be that aboard the "Benjamin Franklin" which would have a capacity slightly over 23,000 cubic meters. Based on the geometry of possible ship collisions, spills of 37,500-cubic meters constitute 90 percent of all ship tank ruptures, according to the SAI study. The remaining 10 percent of the major spillage incidents would represent a "maximum credible" spill volume of 75,000 cubic meters. Beyond this, a greater spill size would require extensive damage to three or more tanks and is not considered by the staff to be a physically credible incident.

The SAI study indicates that for a 37,500-cubic meter spill, a flammable plume could travel downwind from 1 to 6 kilometers (0.6 to 3.7 miles) depending on wind speed. This result compares favorably with a limited independent FPC staff study that predicts a downwind travel of 3.5 kilometers (km) for a similar size spill under neutral air stability conditions and 5-mile per hour wind conditions. 1/ A distance limit for plume travel was not given for a 75,000-cubic meter spill in the SAI study. The FPC study predicts a 4.8 km maximum downwind travel for the 75,000-cubic meter spill.

The collision probability of a tanker delivering LNG to Everett was 1×10^{-5} per transit. The single trip probability of a tanker accident during harbor transit which would result in a tank rupture and subsequent LNG spill was 1×10^{-6} per transit.

1/ Attachment 1 of the Supplement to the Final Environmental Impact Statement For the Construction and Operation of an LNG Import Terminal at Staten Island, New York; December 30, 1975. Docket Nos. CP73-47 et al. and CP73-132 et al.

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The probability of immediate ignition following a collision and spill is assumed to be 90 percent. The probability of ignition of the plume while over water, but not at the source, was assumed to be zero. Over land the probability of ignition was modeled assuming that on the average, there is one potential ignition source per 2,000 square meters (m^2) in populated regions and that each source produces ignition only 1 percent of the time. Source densities in industrial areas were estimated to be lower than those in residential regions. The choice of these parameters was felt to provide conservative estimates of risk.

The risk consequence analysis was based upon the impact of pool and plume fires and the associated thermal radiation from each. The level of thermal radiation required to cause fatal burns is assumed to be 5,700 Btu/hr. -ft^2. It was assumed that 20 percent of the people within the area exposed to this level of radiation were fatalities. This is based on surveys that have indicated that the fraction of people out of doors and not otherwise effectively shielded from radiation is 20 percent during daytime. The fraction is much smaller at night.

The SAI study calculated the frequency of occurrence of fatality levels in the Everett LNG ship system as shown in Table 12. By plotting this data, a histogram of accident fatality as a function of fatalities per accident for potential ship collisions in the LNG system can be obtained. This histogram is shown as Figure 19. The histogram indicates that even for a small ship accident (1 to 100 fatalities) the frequency is 9×10^{-6} per year, or less than one such accident every 100,000 years on the average. This histogram was then integrated by computing the sum of the products of the frequency for each bar and the average fatality value of each bar. The result is Figure 20, which shows the average annual fatalities (cumulative total) as a function of fatalities per accident.

The risk per person per year of exposure to the LNG system is displayed in Table 13 for various distances from

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Table 12 Frequency of Occurrence of Calculated Fatality Levels in the Everett LNG Ship System

Fatality Level	Frequency of Occurrence
1-100	9.0×10^{-6}
100-1,000	1.0×10^{-5}
1,000-2,000	1.3×10^{-6}
2,000-10,000	1.2×10^{-7}
10,000-20,000	1.4×10^{-8}
20,000-30,000	2.4×10^{-11}
30,000-40,000	7.7×10^{-14}
40,000-50,000	2.6×10^{-16}
50,000-100,000	1.4×10^{-18}

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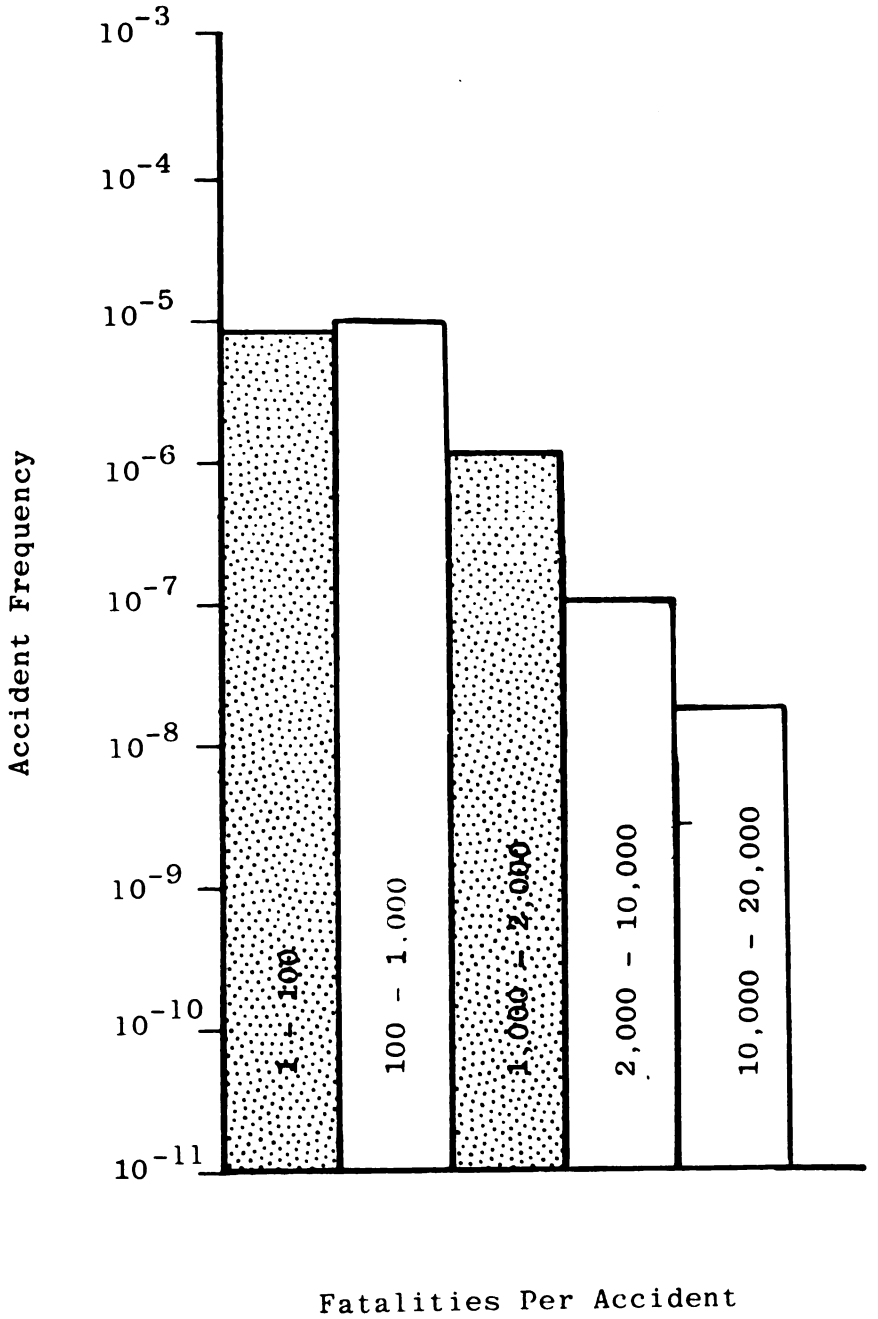

Figure 19 Histogram of Accident Frequency versus Fatalities per Accident (LNG Ship Collisions).

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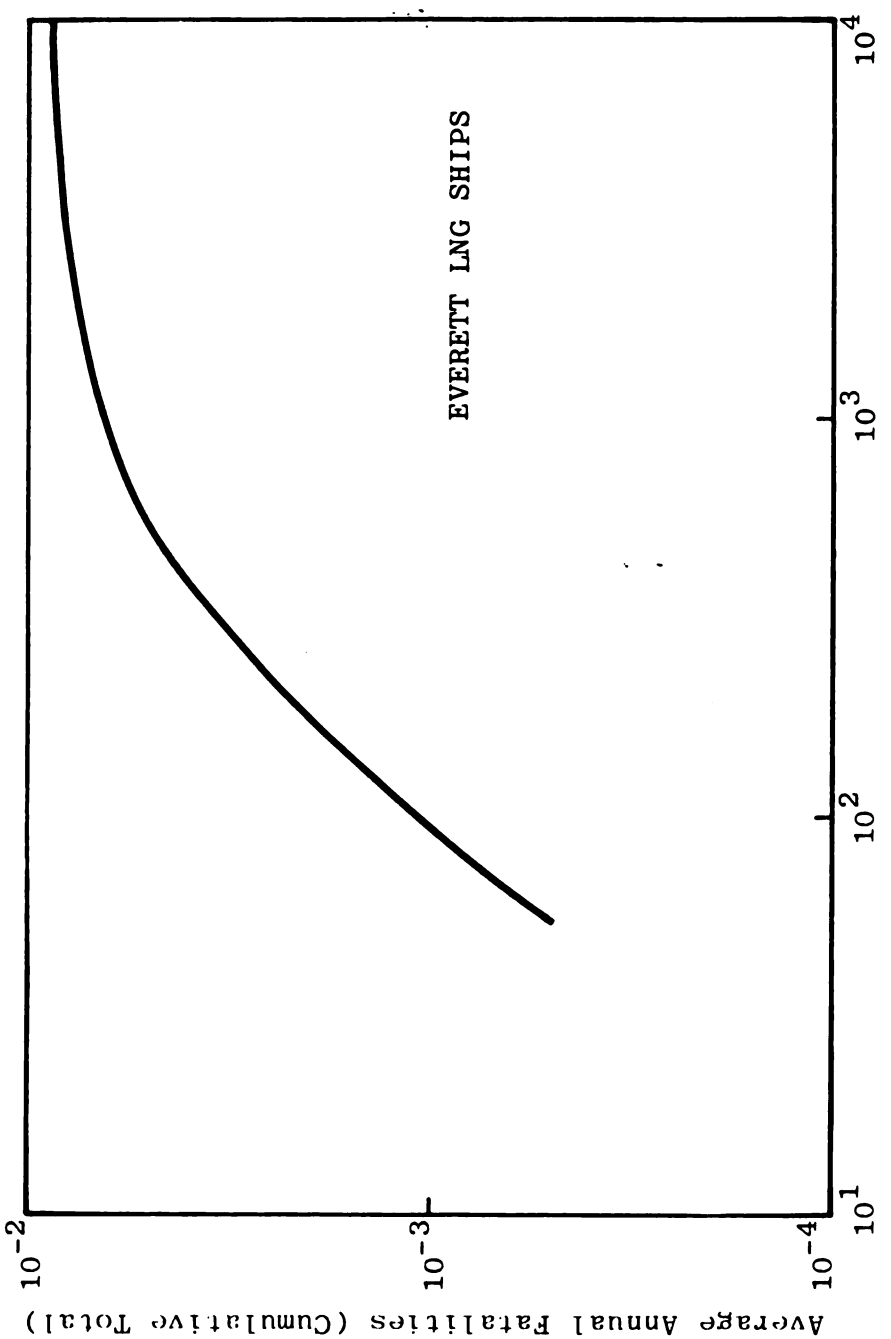

Figure 20 Average Annual Fatalities (Cumulative Total) as a Function of Fatalities per Accident

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the spill zone center for the spill zones indicated on Figure 21. Figure 22 shows the risk contours along the shores of the LNG tanker route where the risk would be either one chance in 1,000,000 or one chance in 100,000 of a fatality per person per year of exposure to the LNG tankers.

Figure 23 compares the fatalities from LNG fires with the historical frequency of annual fatalities from all fires in the United States and Canada. The data from LNG fires are taken directly from Table 12. From SAI's study, the expected increase due to the LNG system is only about 0.0001 percent, which is negligible.

Based on Table 13, the highest average level of risk of a fatality per person per year of exposure is less than one chance in 3,200,000. It is of interest to compare the results obtained here with death from other causes. The deaths resulting from other causes are summarized in Table 14. These data are from the U.S. death statistics for 1972. It is especially relevant to note that the probabilities of death from fires and burns nationwide are one in 30,000 or over one hundred times as great as for the risk from LNG traffic in the Everett system.

The previously mentioned probability of a large-scale LNG spill of 1×10^{-6} per transit indicates that a major LNG tanker rupture and resulting LNG spill during operations in Boston Harbor would be an unlikely event. However, it should be noted that the risk of a large LNG spill would be present on every upriver transit of the LNG tankers and that primary emphasis on safe shipping practices would be essential in order to assure the integrity of the LNG cargo tanks. LNG tankers are designed for superior maneuverability and strength and would be equipped with advanced electronic navigational aids. This navigational equipment would include a collision avoidance computer system which would track, display on a screen, and automatically alert the operator if a collision with any ship or land mass was possible. Section 4 of this environmental impact statement describes in detail the design aspects of the tanker strength,

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maneuverability, and navigational and safety equipment which, in combination with each other, serve to mitigate the possibility of a serious tanker accident.

The SAI study also gives a risk comparison between major causes of death in the U.S. and LNG tanker operations. The conclusion which has been drawn concerning LNG tanker operations is that the risk to the public is orders of magnitude less than for other daily risks to which people are presently exposed.

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Table 13 Risk Levels Expressed as Probability of a Fatality Per Person Per Year of Exposure

Everett LNG Ship System	Fatalities Per Person Per Year at Radius from Representative Spill Zone Center	
	0-2 km	2-4 km
Zone A		
Case 1	2.6×10^{-7}	1.2×10^{-9}
Case 2	5.4×10^{-8}	2.9×10^{-10}
Total	3.1×10^{-7}	1.5×10^{-9}
Zone B		
Case 1	3.2×10^{-8}	5.4×10^{-9}
Case 2	4.4×10^{-8}	9.0×10^{-10}
Total	7.6×10^{-8}	6.3×10^{-9}

CASE NO.	CASE DESCRIPTION
1	37,500-cubic meter instantaneous spill on water (1 ship tank)
2	75,000-cubic meter instantaneous spill on water (2 ship tanks)

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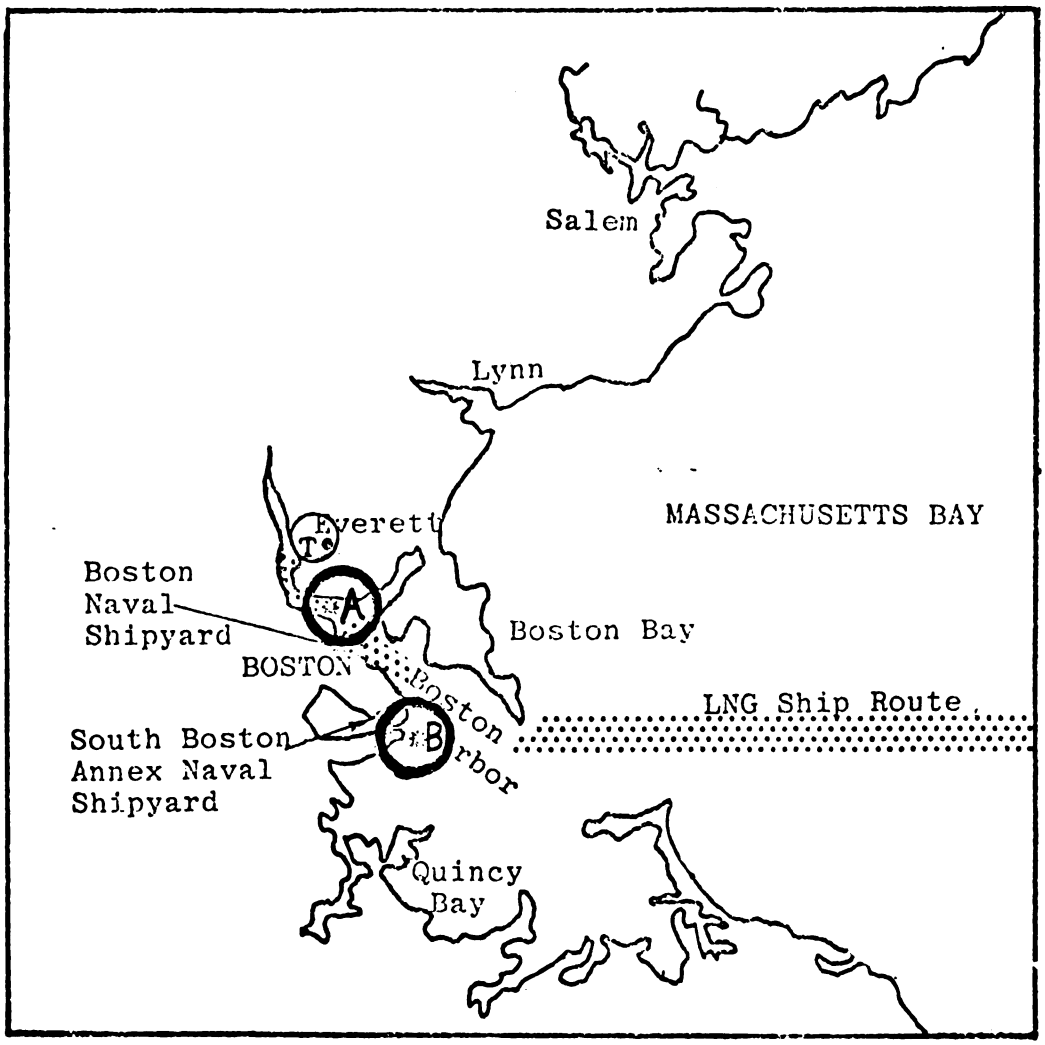

Figure 21 Map of LNG Terminal Area

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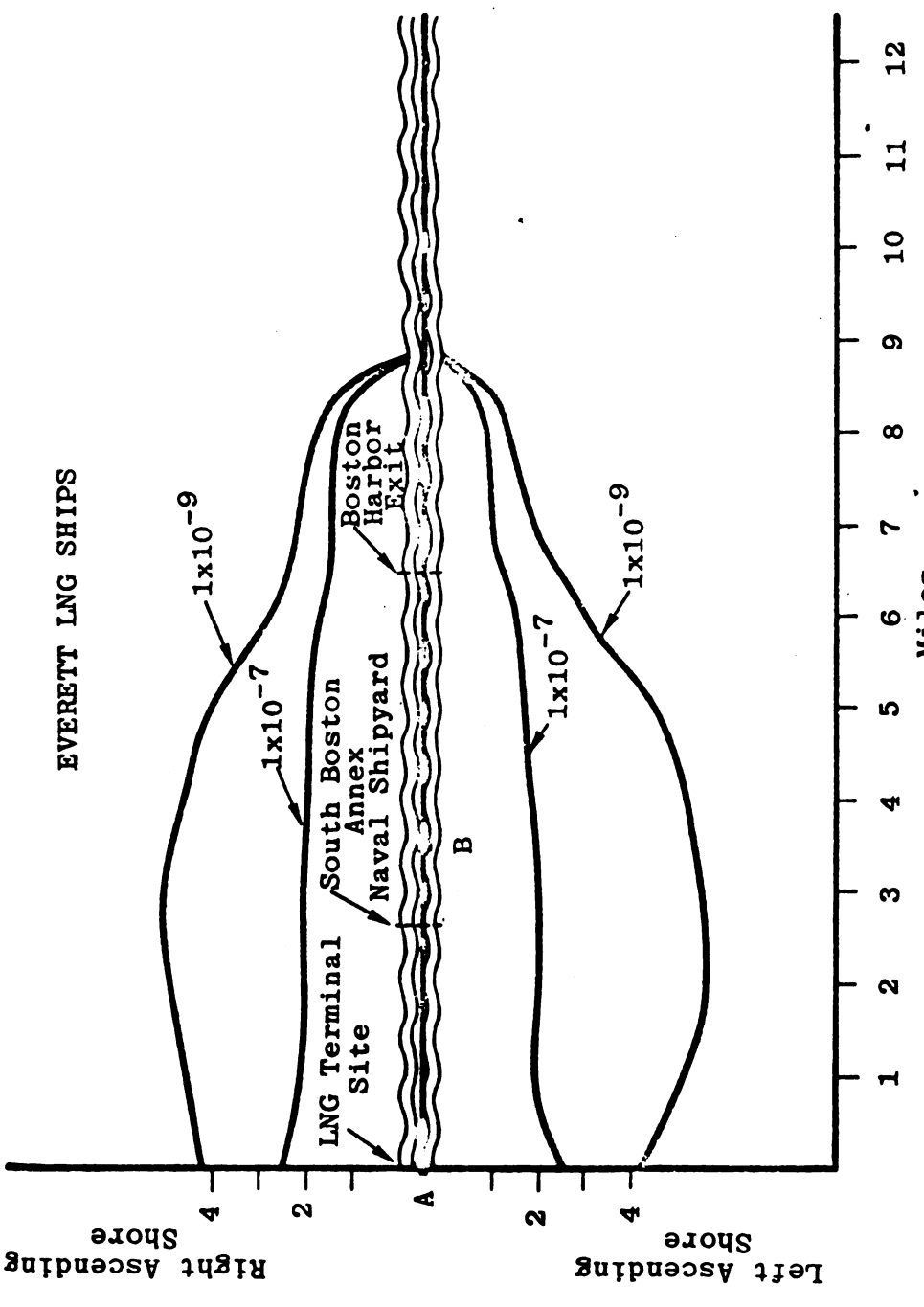

FIGURE 22 SCHEMATIC CONTOURS OF THE FATALITIES PER PERSON EXPOSED ON SHORE

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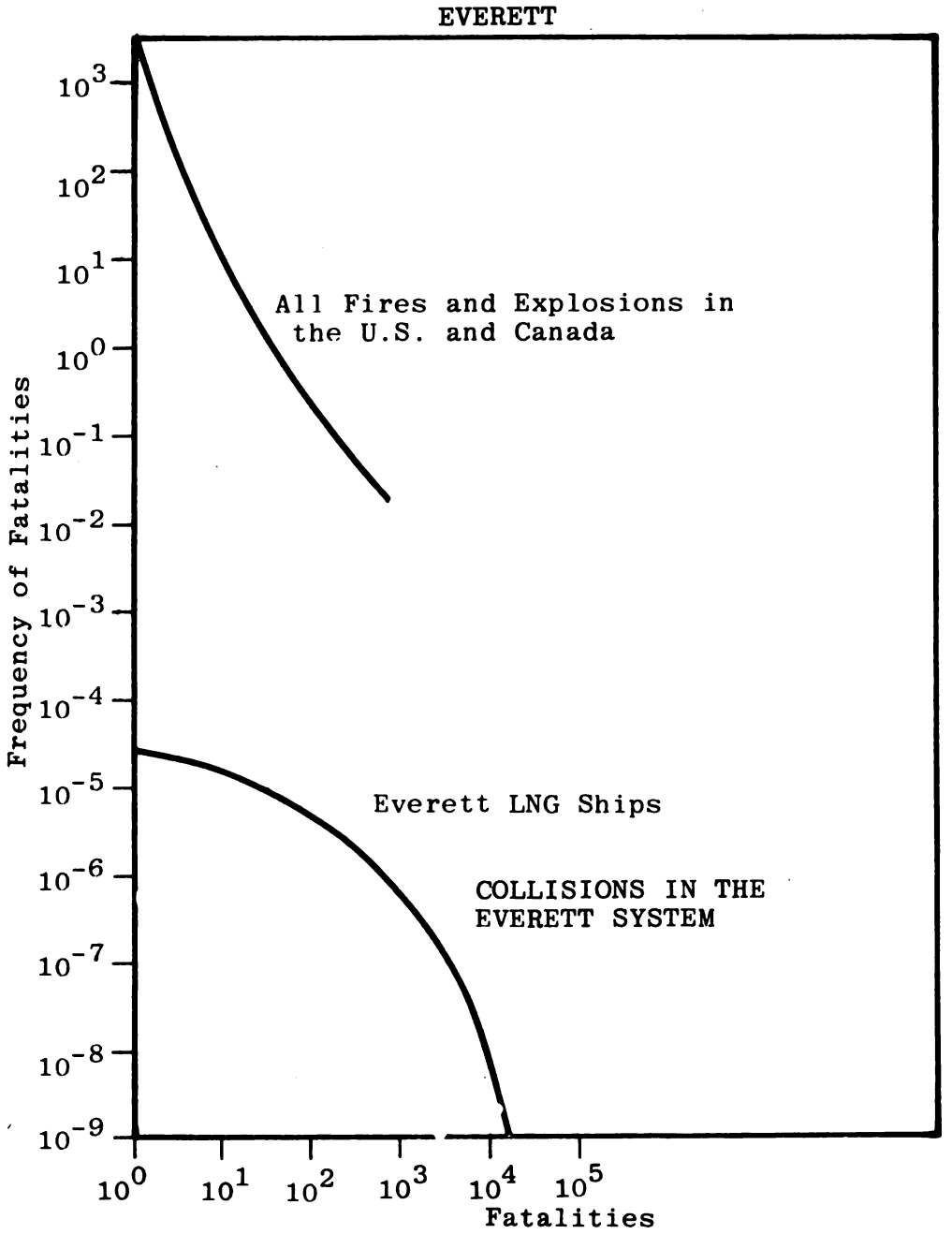

Figure 23 A Comparison of the Frequency of Fatalities From LNG Tankship Collisions to the Frequency of Fatalities From Fires By All Causes

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TABLE 14

COMPARISON OF MAJOR EVERYDAY CAUSES OF
DEATHS IN THE UNITED STATES (1972)
TO THE RISK FROM LNG MARITIME OPERATIONS

Cause of Deaths	Probability Per Person Per Year*
LNG Marine Operations Fires	3.1×10^{-7}
Transportation Accidents	2.8×10^{-4}
Suicide	1.2×10^{-4}
Home Accidents	1.1×10^{-4}
Crime (Homicide)	9.0×10^{-5}
Occupational Accidents	7.0×10^{-5}
Recreational (Accidents Estimated)	6.0×10^{-5}
Fires and Burns	3.3×10^{-5}
Acts of God **	1.6×10^{-5}

* Based on population of 202 million.
** Tornadoes, hurricanes, floods, lightning, etc.

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4. MEASURES TO ENHANCE THE ENVIRONMENT OR TO AVOID OR MITIGATE ADVERSE ENVIRONMENTAL EFFECTS *

Avoidance or mitigation of any adverse effects to the environment, the regional economy, and the safety of the public and plant personnel is essential in projects involving liquefied natural gas. Approval of Federal, state, and local agencies is required, and their regulations must be followed. These agencies, their jurisdictions, and the statutes and codes defining their authority are listed in Table 15. Certain specific standards pertinent to construction, operation, and safety requirements are listed in Table 16.

LNG spills or fires would pose the greatest potential hazards in the overall operations of the LNG terminal. Safety measures necessary to avoid such hazards demand the utmost consideration in the design and operation of the LNG terminal and its related shipping activities and are described in the following pages.

The LNG tankers "Descartes" and "Ben Franklin" would be designed with features to provide added safety during their operation and would include double hull construction, an inert gas purge system, collision avoidance radar systems and navigation aids, emergency shutdown systems, and fire detection and extinguishing systems. The double hull design would provide an added safety factor to protect the LNG cargo tanks. Both the "Descartes" and "Ben Franklin" are cryogenic tankers of the Conch Ocean design, which features the Technigas stainless steel "waffled" primary barrier cargo containment system. Both ships have six various sized stainless steel cargo tanks. A sketch of a typical web frame section, applicable to tanks 3, 4, or 5 on the "Descartes" and "Ben Franklin" are shown in Figures 24 and 25, respectively. The cargo tanks, in effect, would be protected by two hulls. The inner hull of the "Descartes would be separated by a distance of approximately 5 feet from the bottom of the tanker (outer hull), while the "Ben Franklin" would have an equivalent distance of approximately 7 feet. The sides of the tanker would also be protected because of the double hull construction. Therefore,

*The following description is compiled from applications, pleadings, and workpapers submitted in response to data requests, and other materials furnished by the applicants.

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TABLE 15

AGENCIES AND THEIR JURISDICTION
TERMINAL - CONSTRUCTION, OPERATION, AND SAFETY
Including Docking and Unloading Area,
and Storage Tanks
SHIPPING - TANKER OPERATION AND SAFETY

AGENCY	JURISDICTION, STATUTES, STANDARDS, OR CODES
Federal	
1) Army Corps of Engineers - U.S. Department of Conservation	- Approve construction of dock facilities and dredging in tidal waters below the mean high water line; Assess environmental impact on harbor River and Harbor Act of March 3, 1899 Sec. 10 Regulations on Navigable Waterways
2) Environmental Protection Agency	- Review air, water, and noise impact on environment; NEPA-1969, Clean Air Act, Noise Control Act, Federal Water Pollution Control Act
3) Department of Interior-Bureau of Sport Fisheries and Wildlife	- Review impact on biotic communities Fish and Wildlife Coordination Act
National Park Service	- Insure the protection and preservation of historically significant properties according to the National Historic Preservation Act of 1966.
4) Federal Aviation Agency	- Approve structure height in accordance with aviation lanes; Federal Aviation Regulations Part 77 Sec. 77.25

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TABLE 15 (cont'd)

AGENCY	JURISDICTION, STATUTES, STANDARDS, OR CODES
5) Federal Power Commission	- Approve facilities; authorize the importation of natural gas; Natural Gas Act
6) Federal Energy Administration	- Review air quality impact, energy supply and natural resource development, and land use impact on environment
7) Department of Transportation (Office of Pipeline Safety)	- Establish standards for pipeline operation and safety as set forth in CFR Title 49, Part 192
8) U.S. Coast Guard (Department of Transportation)	- Requires training of Marine officers and seamen regarding oil pollution and methods of prevention: Regulates ship traffic, conducts inspections, and insures ship safety: Approve design and operation of dock facilities: approve vessel design and operations; Regulate safe shipping practices. OHA, OSHA Ports and Waterways Safety Act of 1972, "General and Specific Requirements for LNG/LPG Operations"
9) U. S. Bureau of Ships	- Oversee ships and ship operations
10) Maritime Administration (Department of Commerce)	- Approve ship design and specifications "Standard Specifications for Merchant Ship Construction", Dec. 1972

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TABLE 15 (cont'd)

AGENCY	JURISDICTION, STATUTES, STANDARDS, OR CODES
State	
Massachusetts Department of Public Safety	- Permit for construction, maintenance and use of terminal; approval for sailing and docking at Everett Terminal
Massachusetts Department of Public Utilities	- Permit to store and transport LNG
Massachusetts Department of Public Works	- Permit to construct docking facilities, et al.; Everett Terminal
Local	
City of Everett	- Permit to maintain and operate LNG terminal at Everett
Everett Fire Department	- Review, approve and inspect LNG facilities

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TABLE 16

List of Codes, Standards and Regulations governing design and construction of liquefied natural gas facilities in Everett, Massachusetts.

A. Commonwealth of Massachusetts

1. Department of Public Utilities 11725-E (Publication #5063), Massachusetts Gas Distribution Code, October 29, 1971.

2. Department of Public Safety, Board of Fire Prevention Regulations Form FPR-8, Rules and Regulations Governing Construction, Location, Use and Maintenance of Tanks and Containers.

B. General

1. NFPA 59A-1967, Standard for Storage and Handling of Liquefied Natural Gas at Utility Gas Plants, National Fire Protection Association, 1967 Edition with Interim/Amendment Effective April 2, 1969.

2. NFPA 20-1971 Centrifugal Fire Pumps.

3. API Std. 2510A, Design and Construction of LNG Installation at Marine and Pipeline Terminals, Natural Gas Processing Plants, Refineries and other Industrial Plants, American Petroleum Institute, 1968, with December 1969 Addendum.

4. Uniform Building Code, 1967 ed., International Conference of Building Officials.

C. Pressure Components

1. API Std. 620, Recommended Rules for Design and Construction of Large, Welded, Low-Pressure Storage Tanks, American Petroleum Institute, Fourth Edition 1970, with June 1971 Supplement and Including Appendix Q, Low-pressure Storage Tanks for Liquefied Natural Gas.

2. ASME Boiler and Pressure Vessel Code, Section VIII, Division 1, Pressure Vessels, Am. Soc. Mech. Engrs. 1968 with subsequent addenda.

3. TEMA Stds. C and R, 4th ed., Tubular Exchanger Manuf. Assoc., Inc., 1967.

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4. ACI 318-1963, ACI Building Code Requirements for Reinforced Concrete, American Concrete Institute, 1963.

5. Design & Construction of Circular Prestressed Concrete Structure, American Concrete Institute, ACI Committee 344, ACI Journal, September 1970.

6. ANSI B31.3 - 1966, Petroleum Refinery Piping, Am. Soc. Mech. Engrs., 1966.

D. Ship and Barge

1. Rules for Building and Classing Steel Vessels, American Bureau of Shipping, 1969, including:

   a. Supplementary Requirements to Section 36, Pumps and Piping Systems. Cargo Handling Systems, for Liquefied Gases at or Near Atmospheric Pressure and at Temperature Below Atmospheric.

   b. Supplementary Requirements Section 44, Vessels Intended to Carry Liquefied Gases.

2. Rules for Building and Classing Steel Barges for Offshore Service, American Bureau of Shipping, 1967.

3. Tentative Guide for Determining Scantlings of Independent Cargo Tanks, American Bureau of Shipping, 1963.

4. Guide for the Structural Analysis of Independent Tank Barges, USCG, January 1966.

5. Title 46, Shipping Parts 1-146, Code of Federal Regulations, Revision of 1 January 1968 as revised July 1, 1969 (Federal Register, Vol. 33, No. 245, December 18, 1968, Part II).

6. Navigation and Vessel Inspection Circular, USCG:

   a. No. 7-67, Steels for Low Temperature Service;

   b. No. 2-71, Pipe Stress Analysis Calculations, Procedures for submission of;

   c. CG239 Part 126.05B Security of Vessels and Waterfront Facilities - May 1, 1968.

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E. Other

1. AISC Manual of Steel Construction, Am. Inst. Steel Constr., 1967.

2. NFPA No. 70, National Electrical Code, Nat'l Fire Protect. Assoc., 1968.

3. Tech. Std. CGA 341, Insulated Tank Truck Specification for Cold Liquefied Gases, Compressed Gas Assoc. 2nd ed., 1970.

4. Manual Sheet TS-4, Recommended Practice, Unloading Flammable Liquids from Tank Cars Manufacturing Chemists Association.

5. Occupational Safety and Health Standards Code of Federal Regulations, Title 29, Chapter XVII, Part 1910.

6. Recordkeeping Requirements under the William-Steiger Occupational Safety and Health Act of 1970.

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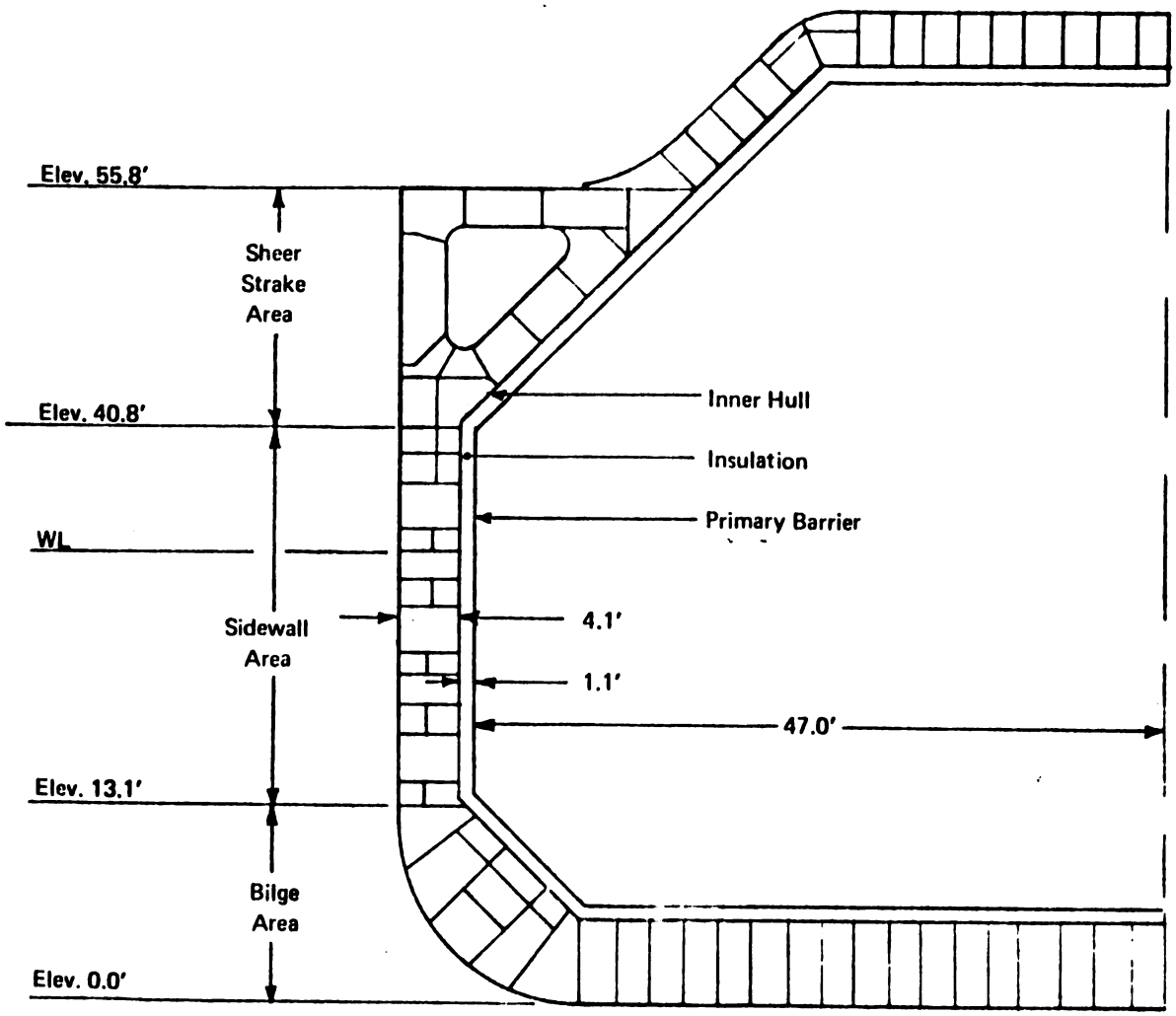
Figure 24



TYPICAL WEB FRAME SECTION
TANKS 3,4,5 –"DESCARTES"

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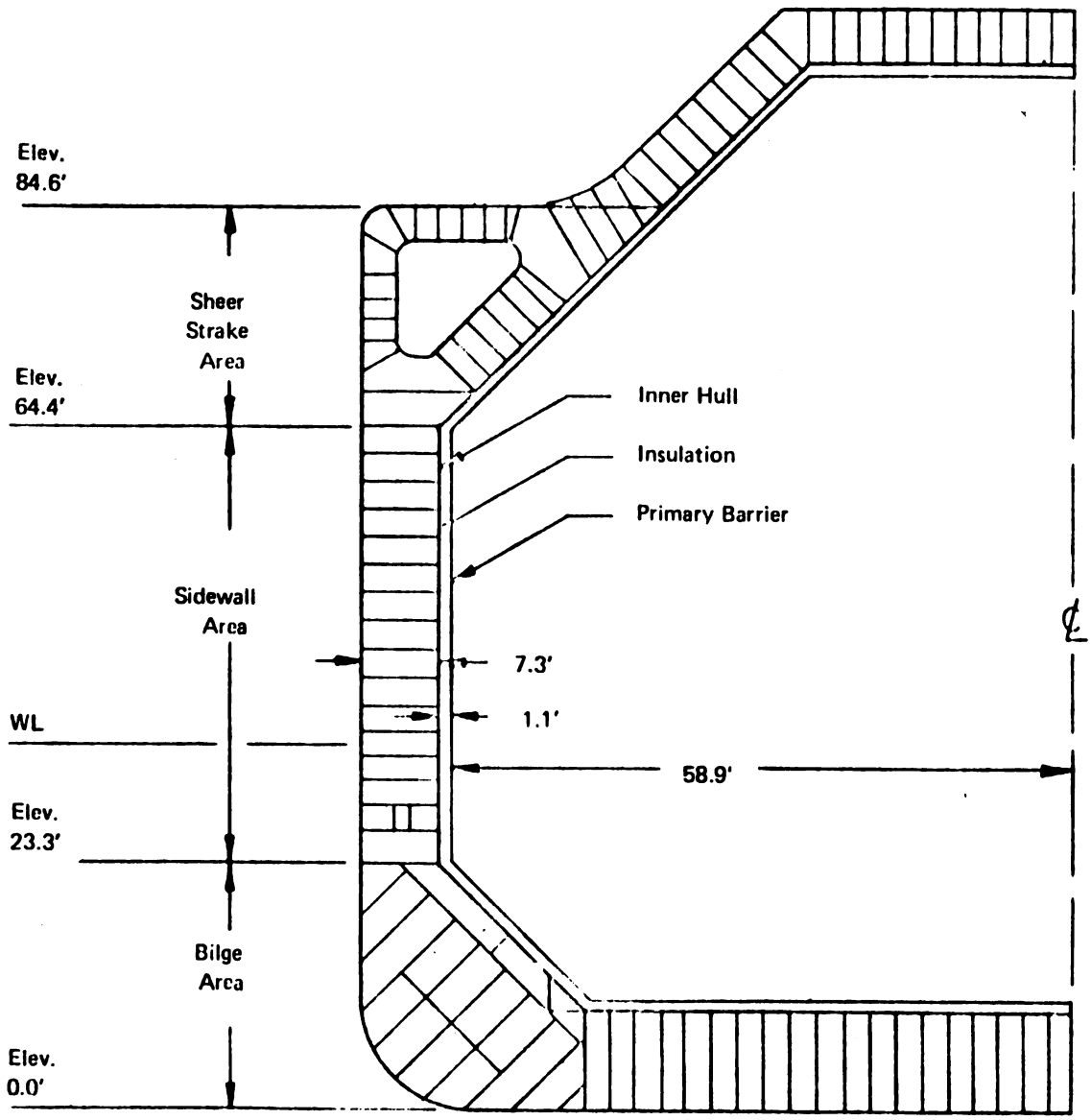
Figure 25



TYPICAL WEB FRAME SECTION
TANKS #3,4,5 – "BEN FRANKLIN"

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an LNG spill could only occur if the two hulls and the cargo tank walls were ruptured. The double hull design would provide safety to the integrity of the LNG cargo tanks in low impact collisions, rammings, and grounding accidents.

Nitrogen, or some other noninflammable gas, would be used to purge the space between the cargo tank and the inner hull to prevent the formation of a combustible gas mixture in the event of a minor LNG leak in the cargo tank. This space contains insulation panels consisting of balsa wood layers faced with plywood forming a vapor and liquid tight secondary barrier. Balsa wood is chosen because of its low thermal conductivity and its ability to withstand compressive and sheer stresses. In addition to the inert atmosphere surrounding the containers, inert gas would be used for the instrumentation system requirements, purging of piping before and after LNG unloading operations, and to purge empty cargo tanks before aeration for personnel entry. The tanks would be purged again before the introduction of LNG for cargo tank cooldown. The use of an inert gas to purge cargo tanks, spacings, and cryogenic piping would prevent combustible vapor formation and eliminate the possibility of explosion.

Boil-off vapor from the cargo tanks would be used to supplement propulsion fuel or for steam generation on the tankers during normal operations. Boil-off vapors would not be vented to the atmosphere except in an emergency situation. Each tank on the "Ben Franklin" would be fitted with two automatic safety relief valves, sized according to U.S. Coast Guard regulations to prevent the tank from being overpressured, even under fire conditions. The relief valves would be set to open at a pressure of about 3.25 pounds per square inch gauge (psig). The normal operating pressure of the cargo tanks would be approximately 1 psig under calm sea conditions and greater than 1 psig but less than 3.25 psig under unstable sea conditions. The discharge of the relief valves on each tank would be piped into a vent mast, discharging about 45 feet above deck level. The relief valve system for the "Descartes" is similar to that described for the "Ben Franklin." Both vessels have vent stacks fitted with powder snuffers in the event the discharging gas were ignited. It

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should also be noted that U.S. Coast Guard regulations prohibit any venting in U.S. waters, and vessels must have the ability to contain or consume vapors for a minimum of 21 days.

The LNG tankers would be fitted with an automatic gas detection system to monitor all spaces in which leaked cargo may accumulate, such as spaces surrounding cargo tanks and spaces containing cargo-handling machinery. An alarm would be activated at concentrations between 25 and 30 percent of the lower flammable limit* of methane. A fire detection system would be fitted to monitor the machinery spaces. An emergency shutdown system would be provided to stop all cargo-handling equipment and to isolate the tank piping by closing key valves in the event of a cargo leak. All major components or equipment such as cargo pumps, cargo fill valves, and boiler master gas valves would be automatically shutdown by electronic interlocks upon the sensing of abnormal conditions. Visual and audible alarms would warn of an abnormal or hazardous condition in both the bridge and the cargo control room. Such alarms would be activated by signals from the following sensors:

1. Cargo hold temperature.
2. Bulkhead temperature.
3. Cargo tank pressure.
4. Cargo pump discharge pressure.
5. Cargo hold pressure.
6. Liquid cargo level.
7. Leaked gas detection.
8. Valve control supply pressure.

The fire extinguishing system aboard the "Ben Franklin" would consist of a dry powder system, a fire main system, a foam system, and a steam smothering system. The dry powder system, with a capacity of about 22,500 pounds, would be provided for gas fires. The fire main system, supplied by two 400-gallon per minute (gpm) fire pumps and a 900 gpm emergency fire pump, would run the length of the main deck as well as throughout the accommodation and machinery spaces. Hydrants with hose

* Lower Flammable Limit is defined as a 5 percent mixture of methane in air.

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stations, nozzles, and applicators would also be provided. Both medium and high expansion foam systems would be provided in the machinery spaces to fight fuel oil fires. The steam smothering system would be fitted to protect all fuel oil tanks and forward storage areas. Appropriate portable CO_2, foam, or water extinguishers would be fitted throughout the ship and a water spray system would also be provided to cool cargo tank domes and piping and the deck house front in the event of a cargo fire. A similar fire extinguishing system exists aboard the "Descartes." In addition, both vessels would be capable of hooking up to a shoreside water supply in the event of a fire at the terminal docking facilities.

Each tanker would be equipped with both 3-centimeter and 10-centimeter radar units. Either radar could be connected to a computerized collision-avoidance system, which would provide the tanker captain with all-weather capability to determine the location, speed, and course of all ships having a collision potential with the LNG tanker. Advance warning, indicating the need for corrective action, would be displayed on the screen if a collision course was computed. The computer system would then allow the ship's officer to test different possible corrective actions by immediately displaying the results of the corrective action before executing a course change. A radio direction finder, two depth sounders, a magnetic speed log, and a DECCA navigation system would also be provided. The communication equipment would consist of two multi-band radio receivers, a multi-band code transmitter, a single side-band voice transceiver, and a 40W transceiver. A VHF multi-channel radio telephone transceiver would also be provided to allow bridge-to-bridge communication with pilots, port authorities, and others.

The "Ben Franklin" would be fitted with a 1,500-hp bow thruster which would be operated from the pilot house and from the bridge wings. The "Descartes" is not fitted with a bow thruster. A bow thruster aids in the maneuverability of a vessel and is most effective at slow speeds, such as those encountered during docking maneuvers.

Both the "Descartes" and "Ben Franklin" are of French registry and Bureau Veritas classed, as well as by the American Bureau of Shipping (ABS) and the U.S. Coast Guard. The "Descartes" was first put into service in 1971. The "Ben Franklin" is presently

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being constructed at the shipyard La Ciotat, which is located near Marseilles, France. The "Descartes" carries a crew of 20 and 9 officers, while the 'Ben Franklin' would carry a 21 man crew and 9 officers. The crews would be of French nationality, although all officers would have a better than average command of the English language as well as French. Training of the officers and crew consists of two parts, onboard and land training.

The onboard training starts basically with the officers and crew gaining experience on LPG ships. These LPG ships transport not only propane but also butane, ammonia, and in some instances petrochemicals such as butadiene. Promotion is from these LPG ships to the LNG service. The land training would consist of four phases. (1) All the officers of the LNG tanker go to a National Marine Fire-fighting School in Cherbourg, France. The school has been in existence for more than 40 years and consists of a 1-week exposure to fire-fighting all types of fires. (2) Officers and crew members go to school for firefighting on actual vessels owned by the firefighters in Marseilles. This school has been in operation for about 30 years. (3) Selected officers and crew members then go to a test facility owned by Gaz de France where specific training is given in LNG firefighting. Actual truckloads of LNG are spilled and the officers and crew learn how to use a wet foam system, as well as powder extinguishing methods. (4) The Captain and the second-in-command take a 1-week course at Grenoble, France, in the navigation and docking procedures required for LNG vessels. This is done on actual models in a pond where they simulate wind, waves, and power conditions with all models in proportion to the size of the 'Ben Franklin" or the "Descartes."

Both the "Descartes" and "Ben Franklin" must meet all U.S. Coast Guard regulations contained in Title 46, Code of Federal Regulations, Part 154. A brief outline for the procedures for obtaining U.S. Coast Guard approval of foreign-built vessels involves: (1) Comprehensive review of vessel plans and specifications by the Coast Guard and reports of inspections and tests made during construction by the Coast Guard or their agents, for instance, the American Bureau of Shipping. The Coast Guard procedures provide equivalent design and safety for all LNG vessels operating in U.S. waters, whether

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of U.S. or foreign registry. Upon satisfactory review by the Coast Guard, the vessel is issued a "plan review complete" letter authorizing it to make an initial entry to a U.S. port. (2) Inspection of the vessel by U.S. Coast Guard personnel at the time of initial entry is made. If satisfactory, the vessel is issued a "letter of compliance" authorizing subsequent entries to U.S. ports for a period of 2 years. And (3) at the end of the 2-year period of validity of the "letter of compliance" and at any time during that period at the option of the U.S. Coast Guard, the vessel may be reinspected to insure that it has been maintained up to the standards in effect at the time of the initial inspection. Discrepancies may result in withdrawal of the "letter of compliance."

In addition, both vessels, while operating in U.S. waters, would have to conform to the "General and Specific Requirements for LNG/LPG Operations" (see Appendix B) and the "U.S. Captain of the Port of Boston, Massachusetts LNG/LPG Contingency Plan." (See Appendix C.) The latter document states that LNG vessels must be escorted by the Coast Guard commencing at Deer Island for the inbound transit and terminate there for the outbound transit. Notification of arrival of an LNG vessel must be made to the Capitan of the Port (COTP) and all applicable state and local agencies at least 72 hours in advance of the vessel's arrival and again immediately prior to the arrival of the vessel. The vessels may only enter the harbor during daylight hours and periods of good visibility. Weather permitting, the COTP may authorize night departures. If the visibility is less than 2 miles, the vessel must:

(1) If at sea, not enter the port without the COTP's permission; or

(2) If in port, notify COTP of position and then proceed to the berth or anchorage, whichever is nearer.

The vessel must moor either bow to seaward and be prepared to get underway on short notice, should an emergency so require, or have a live tug standing by during all cargo operations. A live tug standby would be required on a vessel's first visit to the Boston port. The U.S. Coast Guard would preside over all cargo unloading procedures at the Everett LNG terminal.

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Unloading operations are not permitted and must be stopped if an electrical storm is in the immediate vicinity. In addition, the tankers would be electrically grounded to the onshore grounding system prior to the commencement of unloading operations.

Both the "Descartes" and "Ben Franklin" are designed to minimize the discharge of any polluting effluent within United States territorial waters. There would be no ballast or sanitary wastes discharged into territorial waters. Sanitary wastes would be stored in two holding tanks which have a 4 to 5-day total equivalent capacity. The sanitary wastes would be discharged when the ships are operating on the open seas. The only effluent to be discharged into United States waters would be waste from bilge drains that had been passed through an oil separator. The maximum discharge through the oil separator would be 130 gallons per minute. The quality of this bilge water is not known. However, the "Descartes" and the "Ben Franklin," both foreign built vessels, are required to comply with the rules and regulations established pursuant to the Federal Water Pollution Control Act. In addition, the 1973 International Marine Pollution Convention allows the discharge of oily waters from bilge spaces only if the oil content of the effluent is less than 100 parts per million.

The 30,000-barrel barge "Massachusetts" is a non self-propelled LNG carrier classed by the ABS as "AL PRESSURE TANK BARGE" and rated by the U.S. Coast Guard as suitable for unrestrictive ocean service. As a U.S. built vessel, it must conform to all applicable regulations pertaining to its design and construction as put forth by the Coast Guard under the U.S. Department of Transportation. The barge consists of two cargo holds which contain four 7,500-barrel capacity aluminum cylindrical pressure tanks. (See Figures 26 and 27.) Each hold is separated by a 3-foot cofferdam. Perlite insulation fills the void in the cargo holds. Additionally, nitrogen is introduced into the hold spaces to insure an inert atmosphere. Each cargo tank is 110 feet long by 23½ feet in diameter and is supported horizontally on saddles built up from the mild steel portion of the inner hull. The cargo tanks are 5.5 feet from the outer hull of the barge at its nearest point. A tiedown arrangement prevents vertical movement, while tank axial move-

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ment is prevented by a collision chock. These devices are also intended to prevent the cargo tank from floating in the event of water ingress. Each tank has two penetrations for the deep well cargo pumps and vapor dome for cargo piping connections. The aluminum cargo tanks are each designed so that a pressure relief valve activates automatically at 57 psig. The tanks have been tested up to 88 psig, and it is expected that the burst pressure is greater than this 88 psig. In terms of boil-off, the tanks are designed to permit boil-off, or pressure buildup, for a period of approximately 45 days, based on U.S. Coast Guard design conditions of ambient air being at a temperature of 115°F and a water temperature of approximately 80°F. The normal operating pressure and boil-off rate of the cargo tanks is in the range of 1½ to 3 psig per 24-hour period. Unloading of cargo is accomplished through an unloading arm consisting of a 15-foot inboard pipe and a 16-foot outboard pipe joined by a swivel joint and connected at one end to a flange by swivel joints. This provides a strong yet flexible connection for liquid transfer to and from the barge. This unit is a non-counterbalanced hydraulically operated marine loading arm. Approximately 150 gallons of LNG are left in each tank after unloading for the return trip back to the barge-loading terminal.

The barge is compartmentalized into four areas: a canopy deck, a main deck, a forward machinery space, and an after machinery space. Cargo handling gear and attendant piping is distributed atop the canopy deck. The cargo loading arm near midship, on the starboard side, is mounted on a platform outboard of the canopy deck. The control room, located on the starboard after end of the canopy deck is the operational control center. Data for the various cargo systems are transmitted and recorded in the console located in the control room. All controls and safety alarms are monitored in the control room, which is also the primary communications center for the barge with shoreside facilities. On centerline, aft, on the canopy deck is an 880-gallon liquid nitrogen tank which supplies gaseous nitrogen to the cargo holds, purge systems, and instruments.

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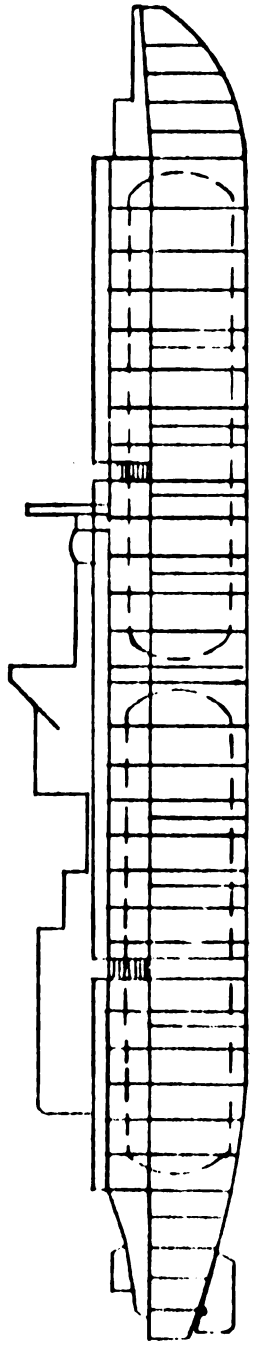
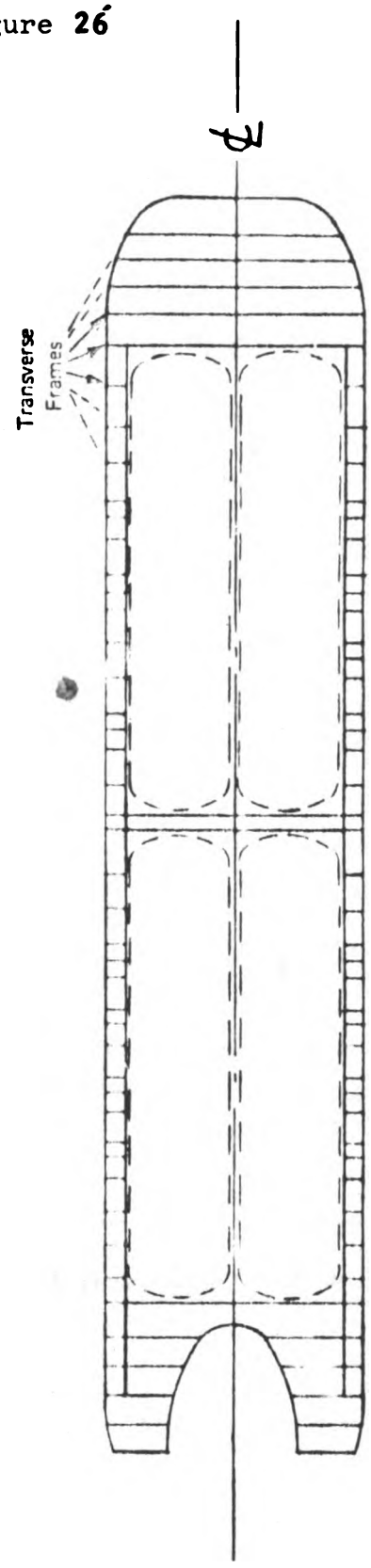
Figure 26



Elevation View Through Tanks



Plan View Through Tanks

GENERAL ARRANGEMENT OF BARGE MASSACHUSETTS

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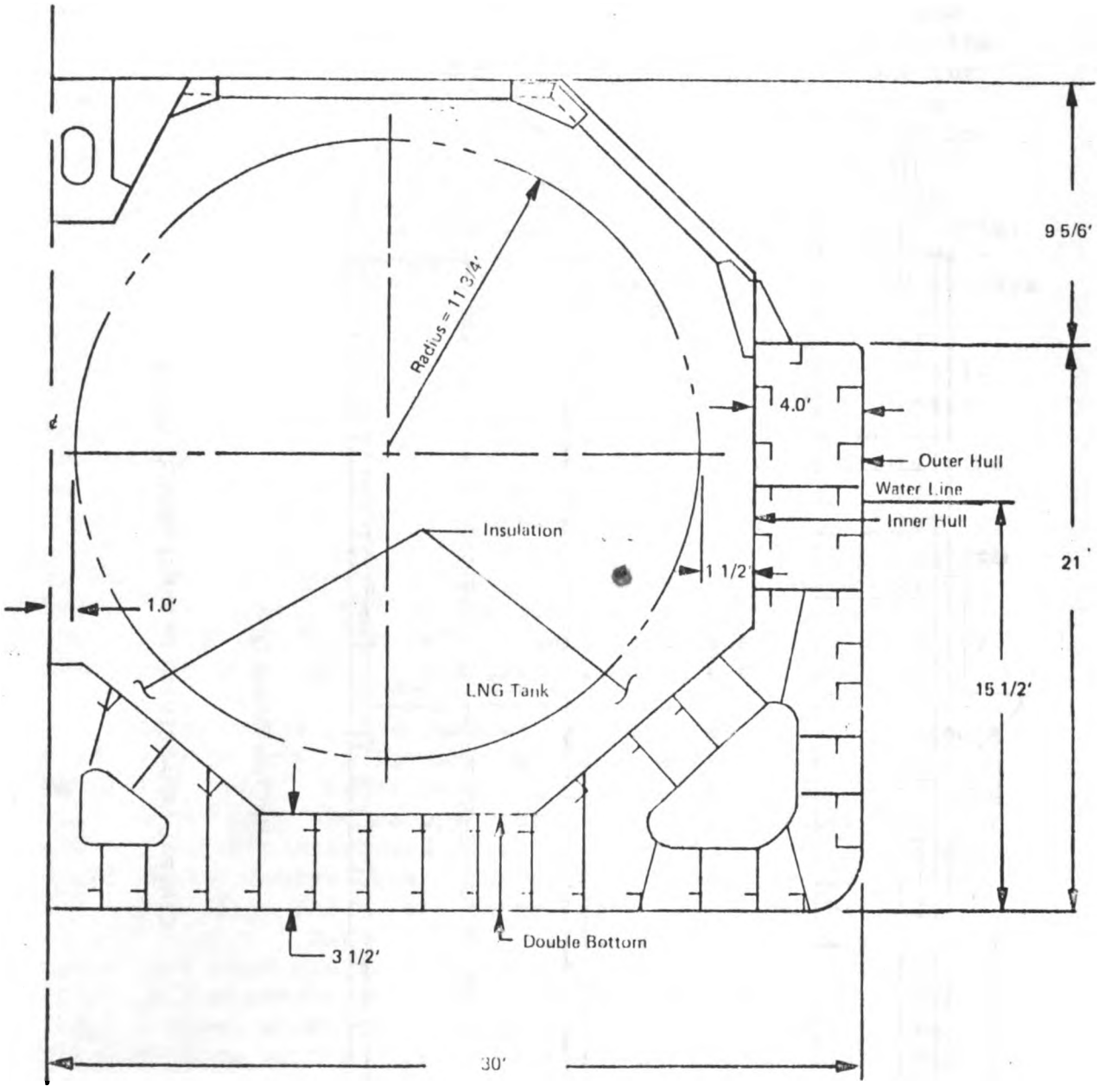
Figure 27



TYPICAL MIDBODY TRANSVERSE FRAME OF BARGE 'MASSACHUSETTS'

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The main deck is limited to the fore deck, after deck, and port and starboard passageways. The main deck forward provides the forward mooring station and access to the forward machinery flat. Equipment on the foredeck includes the anchor windlass, billboard, anchor, and bow thruster control station. On the notched after deck, the barge provides the stern mooring area and access to the after machinery flat. This configuration is part of a notched stern designed to receive a tow boat. The bow is a modified spoon bow, designed to preclude diving when underway at full speed. Equipment stowed on the after deck includes tug attachment pads, adjustable skeg controls, CO_2 bottles, shore and tow boat electrical connections.

The forward machinery space is entered via the booby hatch located on the main deck forward port side. In this area, the bow thruster and its prime mover are located. This consists of a 60KW diesel generator which provides the power for the 400 hp bow thruster located in the tunnel below, via a shaft with a right-angle drive. A hatch located on the main deck starboard side provides access for barge maintenance.

Access to the after machinery flat is via a booby hatch on the main deck aft on the port side. This compartment houses two air compressors, a main switchboard, two ballast pumps, one washdown pump, two air receivers, one air dryer, one 60-KW auxiliary diesel generator, and two 500-KW main diesel generators.

The barge electrical plant consists principally of these two 500-KW diesel generator sets which supply normal power at 450 volts, 3 phase, a.c. 60 Hertz and the 60-KW generator which supplies auxiliary power at 450 volts, 3 phase, a.c. 60 Hertz. In addition to these power generators, there are two other sources of power: (1) a 450-volt, 3-phase, 225-ampere shore connection box located on the main deck aft starboard, and (2) a tug connection provided through a plug receptacle located on the main deck aft portside and fed by a 150-ampere, 208/120-volt, 3-phase, 4-wire supply. In case all sources of power fail, there are three battery lanterns, two in the aft machinery space and one in the thruster room, which would furnish minimum lighting.

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There are three types of fire protection systems on the barge: carbon dioxide, dry chemical, and water. Separate CO_2 systems are provided for each machinery space. Capacities are 600 pounds in the aft machinery space and 300 pounds in the forward machinery space. The CO_2 cylinders and controls for the after machinery space CO_2 flooding system are located on the main deck, port side. The CO_2 cylinders and controls for the forward machinery system are located on the starboard side. The CO_2 systems can be manually operated by using the manual pulls located at the booby hatch for each space. Automatic operation is by means of heat sensors installed below the overhead of the forward machinery space only. A siren alarm is sounded upon activation. Personnel have 25 seconds to evacuate the area before the CO_2 is released.

The barge is equipped with two independent dry chemical systems designed to protect the cargo piping and machinery areas on the canopy deck. The first system involves a turret system which consists of two 1,800-pound dry chemical skids on the canopy deck and may be actuated from any of six locations. Each unit has a 25-pound per second delivery turret with approximately an 85-foot range and a 150-foot headline. The turrent nozzles, which must be aimed from the skids, are capable of being manually opened and closed to control release of the extinguishing agent. The second system is a fixed dry chemical system which consists of two 1,800-pound skids on the canopy deck. The port skid feeds two nozzles on the port side, while the starboard skid feeds two nozzles on the starboard side. Each nozzle has a capacity of 32 pounds per second of dry chemical. All nozzles have 150^{o} coverage in order that the system provide total coverage of the canopy deck cargo piping area. Once the fixed dry chemical system is actuated, it will discharge its entire inventory of powder over a period of 28 seconds. The flow of powder cannot be stopped.

The water system consists of a water spray system and a washdown system. The water spray system is designed to cover the entire cargo piping area and the control room and can be fed from any of the following sources: ballast pump No. 2, washdown pump, shore connections, or tugboat connection. This system is designed to accomplish three tasks: (1) cool and protect surrounding equipment during a fire, (2) shield

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personnel from the heat of a fire, and (3) reduce the possibility of reignition from hot char and metal. Use of the water spray system will not interfere with the use of the dry chemical systems. The washdown system consists of five 1½-inch washdown hoses equipped with combination nozzles. Three of these hoses are located on the canopy deck in the cargo piping area. The other two are located on the main deck forward and the main deck aft. Water for this system can be supplied from the same four sources as the water spray system. During any cryogenic transfer operation, the washdown system is utilized to protect the canopy deck steel from cryogenic spills. The major element of this system is an arrangement of 5-inch dams which divide the central portion of the canopy deck into twelve "pools," insulating the mild steel deck plate from the low temperatures of spilled LNG or nitrogen. During cryogenic transfer operations, these "pools" are flooded with water.

The barge has two distinct alarm systems: cargo and auxiliary. The individual alarms which make up both systems, their respective set points, the locations of each sensor and alarm, the type of alarm, the gear shutdown, and the mode of shutdown are shown in Tables 17 and 18.

Emergency procedures for barge drift have been considered. Unintentional barge drift can occur under one or a combination of the following: tidal range, current, wind, surge from passing waterborne traffic, cargo loading, excessive list, and parting of mooring lines. The possibility exists (though remote) that intentional setting of the barge adrift could also be necessary. While the circumstances dictate specific steps in each emergency, the following procedures would be basic to all barge drift problems along or off berth:

1. Notify all hands, shore facility, and tow boat if in vicinity.

2. Secure cargo operations-- this should occur automatically.

3. Commence washdown system.

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TABLE 17

Cargo System Alarm

Item	Cause	Set Point	Location of Sensor	Location of Alarm	Type of Alarm	Gear Shut Down	Mode of ShutDown
1	Cargo tank low pressure	-1 psig falling	On deck at each dome	Console	Light & horn	Cargo pump & cargo compressor	A
2	Cargo tank high pressure	35 psig rising	On deck at each dome	Console	Light, horn & beacon	Relief valve vents at 57 psi	U T O M A T I C
3	Cargo tank high level	95%	On deck at each dome	Console	Light & horn	Throttle control valve	
4	High temperature compressor discharge	400°F rising	In 12" vapor line (discharge)	Console	Light & horn	425° F rising gas compressor motor	
5	Low temperature compressor suction	Falling	In 16" vapor line (suction)	Console	Light & horn	(a) Gas compressor motor	
6	Compressor discharge high pressure	Rising	In 12" vapor line (discharge)	Console	Light & horn	Gas compressor motor	
7	Compressed air low pressure	60 psi falling	Console	Console	Light & horn	(a) 35 psi gas compressor (b) Cargo pump	
8	Nitrogen pilot line	35 psi falling	Console	Console	Light & horn	(a) 35 psi gas compressor (b) Cargo pump	

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Cargo System Alarm(cont.)

Item	Cause	Set Point	Location of Sensor	Location of Alarm	Type of Alarm	Gear ShutDown	Mode of ShutDown
9	Compressor seal oil low pressure	45 psi falling	Seal oil outlet piping	Console	Light & horn	(40 psi) gas compression	A
10	Compressor lube oil low pressure	12 psi falling	Lube oil control valve piping	Console	Light & horn	(8 psig) gas compressor	U
11	Oil high temperature	160°F	Lube oil control valve piping	Console	Light & horn	(180°F) gas compressor	T O M A T I C
12	Compressor lube oil low level		Lube oil reservoir	Console	Light & horn	(180°F) gas compressor	
13	Compressor motor high temperature		Compressor motor	Console	Light & horn	(180°F) gas compressor	
14	Cargo pump over current		In controller aft machinery space	Console	Light & horn	Cargo pump	
15	Cargo pump low current		In controller aft machinery space	Console	Light & horn	Cargo pump	
16	Compressor over current		Controller	Console	Light & horn	Compressor	

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Cargo System Alarm (cont.)

Item	Cause	Set Point	Location of Sensor	Location of Alarm	Type of Alarm	Gear ShutDown	Mode of ShutDown
17	Gas Detection hold	30% L.F.L.	Two in each hold	Console	Light & horn	Nil	AUTOMATIC
18	Gas detection fwd, aft & control	30% L.F.L.	Two-aft one-fwd one-control room	Console	Light & horn		
19	Compressor low lube oil temperature	60%				60°F compressor	

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TABLE 18 AUXILIARY SYSTEMS ALARMS

Item	Alarm	Set Point	Location of Sensor	Location of Alarm	Type of Alarm	Shut Down
1	Main diesels cooling water high temperature	195°F to 250°F	On diesel	Diesel board in control room	Light & audible	Manual
2	Main diesels lube pressure		Lube oil line	Diesel board in control room	Light & audible	Manual
3	Main diesels over-speed	110% of rated speed	Off the governor			Automatic
4	Auxiliary diesel cooling water high temperature	195° to 205°F		Diesel board in control room	Light & audible	Manual
5	Auxiliary diesel lube on pressure	8-12 psi	Lube oil line	Diesel board in control room	Light & audible	Manual
6	Auxiliary diesel overspeed	1980 rpm	Off the governor			Automatic
7	Bow thruster diesel cooling water high temperature	195° F to 205°F				Manual
8	Bow thruster lube oil pressure		Lube oil line			Manual
9	Bow thruster overspeed	110% of rated speed	Off the governor			Automatic

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Auxiliary Systems Alarms (cont.)

Item	Alarm	Set Point	Location of Sensor	Location of Alarm	Type of Alarm	Shut Down
10	Compressed air system air receivers	Low-120 psi. High-150 psi	Pressure switch on compressor	Nil	Nil	Automatic compressor air CRS
11	Carbon dioxide		Two fwd machinery space		Siren	Automatic or manual full discharge
			Two fwd machinery space		Siren	Automatic or manual full discharge

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4. Energize windlass forward and capstan aft.

5. Heave in mooring lines in a manner that will return the barge to original moored position, bearing in mind that the cargo Chiksan arm is the important consideration.

6. Utilize tow boat assistance (if available).

7. Continue to use washdown hoses on affected area if a spill has occurred.

8. Log the details.

In the event that the barge lines are severed and no connection with the shore exists:

1. Notify all hands, shore facility, and tow-boat if in vicinity.

2. Cargo operational shutdown should be automatic. However, all necessary steps to cease cargo movement must be followed.

3. Utilize tow-boat assistance.

4. Prepare to drop anchor immediately, if it is deemed safe to do so.

5. Attempt to put mooring lines ashore if deemed safe to do so.

6. Continue to use washdown hoses on affected area if a spill has occurred.

7. Log the details.

The first step in either of the aforementioned procedures is one of communication. The barge is outfitted with a sound-powered telephone system for general communication between the barge control room and the after machinery space, portable VHF walkie-talkies for communication between the shore terminal and barge control room and also the barge personnel on deck and the barge control room, and a shore telephone which is connected upon each arrival at a facility to allow communication between the barge and shore control room.

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The barge utilizes a radio-activated anchor. Before the anchor will drop, a five-digit test code anchor frequency number must first be given. The barge control room must then indicate receipt of the five-digit test code number. An additional and separate five-digit number must then be sent in order for the anchor to drop.

The crew of the barge has undergone training programs consisting of lectures on barge operations and general logic systems for safety control. A model of the barge was constructed, and men were sent to Houston, Texas, to observe the construction of the barge. In addition, the crew was sent to a firefighting school and received first-aid lessons. Replacement crews would receive the same training, with the exception of the construction observation phase. The average number of hours each crew member receives in training is between 150 and 200 hours. The crew of the "Amy Moran"-- the tug assigned for duty to the Massachusetts -- has been trained on safety equipment activation in the event of an emergency while the barge is under tow. The barge is unmanned while underway, and therefore the crew of the tug boat would have the responsibility of safety equipment activation during these periods.

Into its structures the DOMAC Everett LNG Storage Terminal has incorporated design and safety systems and safeguards against possible threats to the surrounding community, plant personnel, and the environment. Standards for the terminal were taken from NFPA 59A, 1967, "Liquefied Natural Gas Processing Plants, Refineries, and other Industrial Plants" and DOT Standard 49 CFR, Part 192, "Transmission of Natural and Other Gas by Pipeline."

The dock facility includes several features in its design to reduce safety hazards. The two 12-inch diameter marine LNG unloading arms and the single 12-inch diameter marine vapor return arm are counter-weighted and designed to allow for the following:

1. Tidal variation.
2. Elevation range of ship discharge flanges.
3. Discharge flanges distance inboard from ship's rail.
4. Outward drift.
5. Parallel drift.

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Height of the dock above mean high and low water would be 7½ and 17 feet, respectively. In addition, these arms are designed so as to be manually moved by the dock personnel in the event of a power loss to the dock area. The dock area also contains dry chemical fire extinguishers, combustible gas detectors, and fire emergency water hydrants.

The fire prevention system at the DOMAC LNG terminal consists of essentially three divisions: detection, alarm, and control systems. The detection system consists of ultra violet (UV) flame detectors and combustible vapor detectors. Two flame detectors are located at each vaporizer, and one flame detector is located at each booster pump. Combustible gas detectors are located at each vaporizer, booster pumps, vaporizer motor control center, dock, and each truckload area.

Upon detection of a potential emergency, audible and visual alarms would activate at the control room and terminal area. The alarms would also alert local and municipal support agencies. Communication between plant and/or dock personnel would be achieved by means of walkie-talkies, a plant intercom system located at 18 areas throughout the terminal and dock area, telephone, and marine radio. The alarm system would not automatically shutdown the Everett terminal; however, there are emergency shutdown (ESD) buttons located at the control room, truck-loading stations, vaporizer control panel, and the dock area control panel. These shutdown systems would shut down only critical equipment, except for the button in the main control room which, when activated, would cause total plant shutdown.

The fire control system consists of two networks: a system to extinguish LNG-fueled fires and a system to deal with conventional fires. LNG fires require different methods of control since the use of conventional water spray extinguishers would merely cause an increased vaporization rate of LNG. The control system used to extinguish LNG fires is a dry chemical spray. A dry powder of potassium bicarbonate (purple K) would be propelled by a stream of inert gas to the LNG fire. Dry chemical extinguishers would also be located in various areas of the plant in either portable, fixed skids, or trailer units. The conventional system consists of a

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hydrant network and portable CO_2 extinguishers. The hydrant system would serve a two-fold purpose: to combat conventional fires and a deluge system to protect the outsides of buildings and tanks from exposure to nearby fires. Responses to a questionnaire sent to groups which may be involved in combating a fire at the terminal indicate that experienced plant personnel in association with the Everett Fire Department would probably serve as a primary firefighting force, whereas other local fire departments could assist in keeping nearby structures and equipment cooled and augment the primary force. The local and State police forces could serve as communications and traffic coordinators during a large scale emergency.

The two LNG storage tanks contain several features to guard against tank rupture and subsequent spillage of LNG. Each vertical steel tank is designed to have a single roof, double shell, and double bottom. A single storage tank is actually a two-tank system. The inner tank, constructed of 9 percent nickel steel, contains the LNG. A vapor tight, carbon steel outer tank retains the insulation and would serve as a temporary container for the LNG if the inner tank should fail. LNG is loaded into the storage tanks at the top of each tank in order to avoid line breakage loss of LNG through a bottom connection. The tanks are designed to withstand an internal pressure of 1.5 psig and Zone 2 earthquake forces. The tank piping is equipped with relief valves and vents as a safeguard against overpressurization. If the relief valve were to fail, it is expected that a pressure of between 9 and 12 psig would be required for the roof to open at its periphery. In addition, the tanks are properly electrically grounded and an automatically controlled electric heating system has been provided to prevent ice formation in the foundation.

Surrounding the two tanks is one common dike. This dike is 16 feet high and capable of holding 750,000 barrels of LNG. The dike floor is graded so that any spilled LNG would be directed to a sump having a 10,000-barrel capacity to limit the surface area of the spill. The two tanks are raised on berms the height of the diked area to reduce the chance of liquid contacting the tanks or piping systems should the dike area be filled with LNG. Truck station areas are also equipped with sumps to collect any spilled LNG.

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Mixing and Rollover

The phenomenon of "rollover" is a major concern in the storage of LNG. Rollover takes place in an LNG tank when the lower layer of the liquid becomes superheated because of the hydrostatic pressure of lighter weight liquid above it and suddenly evolves a large quantity of vapor. Layering in LNG tanks results from LNG of different densities and ages which is pumped into a tank at different times. Because LNG is a mixture of different gases with different molecular weights and vapor pressures, the lightest (methane) fraction tends to boil preferentially. Thus "weathered" LNG stored for months may become heavier, although warmer, than freshly condensed natural gas.

An example indicates the severity of this phenomenon. In 1971, an LNG storage tank in Italy experienced a sudden increase in pressure, causing a gas discharge from the tank safety valves and vents which lasted about 3 hours. The equivalent of about 3,400 barrels of LNG were lost. This pulse occurred about 18 hours after the tank had been filled from an LNG ship that had been in the harbor about a month. The tank was filled from the bottom. Because of its age, the ship cargo was more dense than the tank heel, although it was warmer. The cargo stayed in the bottom of the tank while the tank heel stayed on top until the vapor pressure underneath increased to the point of sudden release. During the period before the release, the colder upper layer was warmed by the lower layer so it became heavier and warmer also, which prolonged and intensified the temporary stability. There have been other similar vapor excursions recorded. (27)

Rollover is a problem only because LNG is a mixture of liquids; it cannot occur with pure liquids. Repetitions of such excursions can be prevented by jet-mixing nozzles that thoroughly mix different cargoes with tank heels. Heavy cargoes should be injected into the tank from the top while lighter shipments should be injected into the bottom. Bottom injection should be radially inward to insure thorough mixing.

The probability of LNG rollover has decreased as jet nozzling of LNG has made it possible for off-loaded cargo to be mixed thoroughly with different composition tank heels. Other techniques to be considered include recirculation of

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the stored liquid (destratification by pumping), use of multiple storage tanks to separate cargoes of different densities, judicious design and use of piping to selectively fill tanks from either top or bottom, adequate overpressure capability, and a conservatively designed pressure relief system.

DOMAC does not have the top and bottom loading concept in the design of their tanks. Only top fill capability exists for the two storage tanks. However, DOMAC's piping arrangement allows for recirculation of LNG by pump, intertank transfer, and tank emptying so as to achieve selective loading of incoming LNG. DOMAC also incorporates a pressure relief system for their tanks. In order to demonstrate how selective loading works, the following procedure would apply if the "Descartes" or "Ben Franklin" arrives with a cargo of LNG. If the "Descartes" arrives, the 374,000-barrel tank (Tank 1) would be emptied and the "Descartes" would unload into Tank 1. If the "Ben Franklin" arrives, the 600,000-barrel tank (Tank 2) would be emptied, and the cargo of the "Ben Franklin" would be unloaded primarily into Tank 2, with the excess emptied into Tank 1. At the same time, the contents of Tank 1 would be continually recirculated to achieve thorough mixing and thereby prevent rollover. The staff is of the opinion that the aforementioned procedures, if continually and conscientiously followed, should alleviate any potential problem of rollover at the DOMAC facility.

To guard against hazards to plant personnel and the surrounding environment, an employee safety and training program has been implemented and enforced. Special protective cryogenic clothing and selfcontained breathing apparatus is available to guard against frostbite and asphyxiation. Hard hats and safety glasses are provided. A comprehensive and formal operator training program has been carried out at the DOMAC LNG terminal. This training program should reduce the possibility of human error. Even before the formal training program, operator selection plays an important role in attaining and maintaining a safe operation. Men selected as terminal operators have a minimum of a high school education, prior plant experience in the petrochemical field or related fields, demonstrated mechanical ability and ability to learn quickly.

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The formal training program consists of both classroom and field training. Fundamentals such as properties of LNG, hazards, safety aspects, and firefighting techniques are taught in the classroom, followed by practical application in the field. Manufacturers' representatives conduct classes on specific pieces of equipment such as the marine arms, control systems, LNG pumps, vaporizers, the LNG storage tanks, and boil-off compressors. Startup of the plant was conducted under the close supervision of Distrigas management as well as teams of experts provided by the LNG tank and offsite contractors. Particular emphasis was given to training in fire-fighting techniques. This training was preceded with an analysis of classes of accidents to determine the best strategy and tactics for handling the various kinds of emergencies and design the training courses to meet these problems. This type of operational training was followed with unannounced and unexpected drills that were conducted in as realistic a manner as practical for selected problems. Terminal operators were given drill ground training in the use of hose lines fitted with spray nozzles against small fires and LNG releases for protection of fire fighters when closing valves, making rescues, etc. Refresher training is given periodically. New employees are oriented and trained with the regular crews and given special attention. A detailed terminal operating manual has been prepared. Each function of the plant is covered in detail. The purpose of each function is thoroughly explained. Not only is normal operating procedure covered but also the handling of emergencies from both an operating and fire control standpoint. In addition to the operating manual, detailed checklists contain step-by-step details of plant operations.

Field investigations by the staff and representatives of the Cryogenics Division of the National Bureau of Standards who provide consultation and advisory services to the staff identified two potential problems which should be addressed.

1. The liquid transfer line that extends from the terminal to the dock area passes in close proximity to an automobile junkyard where small mountains of junked auto parts spread against massive but relatively low concrete blocks next to the property line fence. If these mountains of junk grow (and

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there is no evidence to the contrary), it would seem that an undesirable and potentially hazardous situation could develop wherein the junk could roll off the mountain, over the concrete, and onto the transfer line. Even though both the Everett terminal manager and the owner of the junkyard appear to be aware of the problem and possible consequences, the situation is an undesirable one, and every effort should be made to alleviate it. A recommendation is made in the Conclusion section of this report to curtail LNG transfer operations if there is junkyard activity on the piles adjacent to the transfer line.

2. There is no assurance that a spill of LNG from the liquid transfer line between the diked tank area and the dock can be contained within DOMAC property lines. Dike height, ditching, and land slope should, in combination, be sufficient so as to contain within DOMAC property lines the maximum amount of LNG spilled in the event of a transfer line failure. The Bureau of Standards has considered the potential magnitude of a spill from a transfer line on the order of 30,000 gallons, using the line volumes of the two marine unloading arms plus a portion of the amount of LNG remaining between shutoff valves. A recommendation is made in the Conclusion section of this report for DOMAC to provide ditching, etc., to contain this potential spill.

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5. UNAVOIDABLE ADVERSE ENVIRONMENTAL EFFECTS

Some adverse impacts which could not be avoided were incurred by the physiographic and geologic environment. The physiographic features of the project site were unavoidably altered by the construction of the proposed project. Surface elevations were changed in excavating the tank sites and erecting the dike retaining walls. There was also an unavoidable alteration of surface runoff patterns due to the change in surface elevations, soil permeability, and the installation of a storm drainage system. Some soil compaction occurred from construction activities and the physical placement of the facilities on the soil.

Land use was also affected by implementation of the LNG project. Construction of the Everett facilities affected local land use trends and reinforced the impaction of industrialization along the northern shore of the Mystic River. Land use in the vicinity of the LNG storage and ship berthing facilities would be restricted during the operational life of the project. Operation of this project would influence the value of property surrounding the project and affect potential investment in both industrial and residential property. As mentioned earlier, adverse socioeconomic costs for services supplied to facilities by Everett, Massachusetts, would be offset by the increase in tax base provided by the facilities.

Unavoidable adverse effects upon wildlife in the area are minimal due to the previous commitment of the LNG site to an industrial installation. Noise and the movement of equipment and personnel resulting from operation and maintenance of the total project would restrict the establishment of wildlife habitat.

Unavoidable adverse effects upon water quality are the short-term increase in turbidity resulting from dredging necessary to permit ship operations at the wharf, the decrease in dissolved oxygen levels associated with dredging operations, the slight turbidity increase resulting from ship movement through the channel, and the slight turbidity increase resulting from facility runoff.

Air and noise quality would also be affected due to the operation of the terminal and arrivals and departures of LNG vessels. It is expected that these impacts would not significantly affect the quality of the environment in the vicinity of the terminal due to the industrialized nature of the region.

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6. RELATIONSHIP BETWEEN LOCAL SHORT-TERM USES OF MAN'S ENVIRONMENT AND MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY

The LNG facility in Everett is in an industrial area with various oil storage areas along the shore, where ship traffic is commonly seen. Thus, the presence of an LNG facility and its associated ship traffic will not change the industrial character of the area. It does commit the land to long-term industrial use, however, which includes adjacent shore and submerged areas.

Oceanic Spills of LNG

To the extent that American LNG operations and the U.S. Maritime Administration support of them contributes to the increased use of vessels to carry liquefied natural gas, this use is not considered to have an effect upon the future productivity of the oceans.

One of the significant characteristics of liquefied natural gas is the cleanliness associated with transport, storage, or use of this vital energy source. There is no accumulation from spills or leaks of LNG that can be anticipated over a period of years. This is in sharp contrast to movement of other energy sources such as coal or petroleum products. The self-cleaning nature of liquefied natural gas is due to its properties wherein when exposed to the atmosphere it will simply vaporize and disperse within minutes. This appears to hold true regardless of whether small or large amounts are involved.

Natural gas is colorless and odorless and is the cleanest burning of all the naturally occurring fossil fuels. This feature alone makes it highly desirable in the ecology-conscious world of today. It is not considered to be a pollutant to the environment in either gaseous or liquid state with respect to its biological effects.

Although no adverse biological effects on the environment are anticipated, the U.S. Coast Guard, on a regional basis, is presently developing contingency plans for

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liquefied natural gas spills. The plan for the Port of Boston is presented in Appendix C and deals primarily with fire and safety hazards.

Expenditure of Materials and Facilities

The extraction and use of minerals and materials in the construction of the LNG facilities, including tankers, involves a short-term use of our resources with long-term implications. But the long-term impact will be slight, because relatively small amounts of resources have been used in comparison with total national resources and materials can be reclaimed when scrapping vessels, storage tanks, and pipelines. Expected life of the LNG facilities is between 30 and 50 years. Disposition after abandonment could vacate the area, making it available for the same or new industrial use.

Harbor and Land Use

The DOMAC site is already committed to industrialization. The additional presence of an LNG facility and associated increased ship traffic will not change the present character of the area. The 34-acre site was previously occupied by an outdated manufactured gas plant for 85 years. This older plant was considered an intrusion on the aesthetics of even this heavily industrialized area in terms of visual impact, odor and gaseous emissions, noises from coke and coal handling, loading and unloading facilities, and liquid wastes. The removal of the large amount of clutter formerly on all portions of the property and the maintenance of the terminal in a clean condition results in a significant upgrading of the area.

The construction and operation of LNG vessels is coincidental with shipyard conversion and the construction of new port facilities, and also involves dedication of shoreside and submerged lands for those purposes.

The extent to which construction of LNG tankers exerts pressure for such dedication is minor when compared to the construction requirements of the overall maritime

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industry. The effect of LNG development at the terminal site is more completely detailed in Section 3. It does not appear that there would be any major long-term impacts upon the productivity of the area due to the LNG terminal maintenance and operation.

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7. IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

Commitment of raw fuel and mineral resources would be irreversible although, in the case of minerals, resulting products such as steel may be recycled. Dissipation of fossil fuels, when used to produce energy, is irreversible. The time in which the water and land is used is irretrievable, but both resources can be ultimately recycled.

Fuel Resources

Both vessels and terminal facilities would require fuel. Such use is an irretrievable commitment. But considering that this operating fuel would be expended to maintain a large natural gas supply system, it is a minor use of fuel resources. Of course, the natural gas imported through these facilities would be consumed and, therefore, irretrievably lost.

Construction Materials

Construction and operation of the full spectrum of LNG facilities would involve the use of mineral resources, some of which cannot be recovered. Coal, limestone, and other materials are used to produce steel and other materials used in construction of vessels, storage tanks, and pipelines. In operation, vessels and regasification facilities may consume boiloff of liquefied natural gas vapors, bunker fuel, and lube oils. While many materials may be recoverable, such as the steel and aluminum used in construction, other materials are not. The character of these expendable materials is not unique, nor would the quantities used be such that their use would be significant in terms of our national resources.

Harbor and Shipping Channel Use

Sedimentation is normally a problem in coastal waterways, but it is possible to maintain and improve coastal harbors and channels and thereby increase their lifespan and performance. Areas so utilized for vessel

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navigation are not irreversibly committed. Rather, such use is a preemption of an area for a specific purpose and time period. Water areas, especially channels subjected to the heavy traffic of oceangoing vessels, are rarely a safe, multiple-use resource. In the off-channel, near-shore areas, however, recreational boating is possible and would not be significantly curtailed by the proposed LNG activity.

Land Use

Two types of land use commitment are required to construct and operate an LNG importation center: 1) area dedicated to the LNG facility and associated equipment, such as docks and pipelines; and 2) areas for the facilities required to produce the material to build the necessary equipment. Both types of commitment are irretrievable, in that the use of the area is specifically preempted during the life span of the proposed activity.

Construction of LNG tankers, pipelines, and LNG storage tanks will all contribute to pressure for the development of shipyards, port facilities, and steel mills, with attendant dedication of shore-side, submerged land and other land areas. In addition to construction, dredging is another possible irreversible commitment of resources associated with these developments. Areas where these activities will occur are highly industrialized, however, and usually do not support high levels of aquatic or terrestrial life, nor are they normally high priority candidates for reclamation.

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8. ALTERNATIVES TO THE PROPOSED ACTION

Energy Alternatives

In order to avoid the reproduction of the lengthy analysis of technology which would be required to properly address the subject of alternative energy sources, the staff references Energy Alternatives: A Comparative Analysis. This document was prepared by the Council on Environmental Quality with the support of the Department of the Interior and is readily available to the public. Chapters 14 through 16 describe especially well the kinds of alternatives which would be appropriate in an energy-related EIS. Technological, locational, source, fuel switching, and policy considerations are treated.

In addition, the staff believes that in order to meet projected demands for natural gas, this nation must fully explore all possible sources of energy supplies, coupled together with effects and programs of energy conservation. No one source of energy will be sufficient to meet all projected demands.

Site Selection Criteria

The northeast portion of the United States does not have indigenous sources of energy commensurate with demand; hence energy supplies are imported. But importation of LNG in large quantities anywhere along the ocean shores of the northeastern U.S. requires certain minimum characteristics to make the project viable. Once landed on the North American continent, the LNG can be transported by smaller tankers, barges, and trucks and, when regasified, it can be transported by pipelines.

The selection of a terminal facility for transoceanic LNG tankers is a major process. It involves consideration of a number of interrelated criteria. One set of criteria involves those conducive to the success of the project. Other factors for consideration give emphasis to the natural environment and to human activities, especially land use.

Selection of a site best suited physically for LNG importation involves at least eight considerations. (1) The shore facilities must be adjacent to a body of water which is sufficient for maneuvering the class of oceangoing vessels

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(see Table 4) required for the transportation of LNG. Such a deepwater port, if not already in existence within a river or bay, can be constructed offshore even along the open coast. (2) The port must be sufficiently sheltered for year-round operation. (3) Sufficient acreage must be available to maintain harbor and storage facilities. (4) Soil conditions and geologic structure (especially in relation to earthquake hazards) must be suitable for support and physical integrity of large storage tanks. (5) The facility must have adequate transmission systems. (6) Nearness to a major market area is a favorable factor. * (7) The site must be reasonably available for purchase and (8) zoned for or be a potential industrial area.

Since waterways provide the avenue for LNG transportation, coastal waters and shorelines are the first areas where environmental damage may occur. This damage is most likely to be less where there is a natural depth of water to 40 feet (MWL) or more, requiring little if any initial or subsequent maintenance dredging, and where the shoreline is rocky or a stable sandy beach. Tidal marshlands are most susceptible to ecological imbalances and should be avoided whenever possible.

Other factors in the site selection criteria are the population density in the proximity of the facilities, the magnitude of the risk of an accident, and the extent of its consequences. Certainly the health and safety of people in and around the facilities must be regarded to the same extent as those receiving the environmental benefits from the use of LNG.

Having broadly identified the site requirements for the success of an LNG importation facility, the general characteristics of shore area suitability, and the human safety consideration, it is desirable to make a categorical examination of typical types of coastal zone areas potentially available for LNG import terminals. Potential sites can be classified as being rural, industrial, or residential. A site selected in a rural area contains low-cost property and generally will pose the greatest impact upon the natural environment, but in the event of an accident would expose a minimum number of people to the danger. Industrial locations would tend to have a minimum impact on the natural environment, with a greater risk to human safety in the event of an accident. Additionally, adjoining property is of high value and contains its own inherent hazard for accidents which could spread to adjoining facilities. A location in a residential area is intermediate between the rural and industrial

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* When peak shaving and seasonal services, in addition to a terminal service for baseload supplies, are required, it may be essential that the terminal be near to the area served if transmission pipelines during peak shaving periods are operating at peak capabilities.

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extremes; the impact on the natural environment is moderate, and the investment of adjoining property is, in general, of intermediate value. However, the humans exposed to the risk of danger are within family units with almost uniform population density throughout the day and week.

Alternative Sites

The primary purpose of a discussion concerning alternative siting of the Everett LNG terminal would be to provide a rigorous exploration and objective evaluation of the environmental impacts of all reasonable alternative sites, particularly those that might avoid some or all of the adverse environmental effects. This rigorous exploration and objective evaluation of the environmental impacts should be conducted prior to the construction and operation of a specific terminal at a specific location. In the immediate applications, the Everett LNG terminal was constructed prior to the issuance of the Draft Environmental Impact Statement and became operational, as the first east coast LNG import terminal, on November 18, 1971.

The fact that the construction and operation of the Everett facility has taken place leads to the question as to whether the scope of the National Environmental Policy Act (NEPA) was meant to cover alternative siting on an after-the-fact basis. There is either the choice of utilizing the existing facility or not to continue to utilize it. The latter choice would lead to the ultimate abandonment of the project, i.e. the alternative of no project at all. It is felt that NEPA was not promulgated to narrow a project to these extreme choices and that a discussion of alternative sites and locations for the Everett facility would seem fruitless to pursue. The salient point that should be reflected is that the site which DOMAC chose in Everett, Massachusetts, satisfies the set of eight criteria as mentioned previously in the section dealing with site selection criteria.

Recapitulation

In general, it is clear that our society, particularly in the northeast, will not reduce its demand for energy in the foreseeable future. Of the various forms of fuel supplies currently available, natural gas is both the cleanest and most scarce. Although the importation of LNG is only one of a number of supplemental supplies of natural gas, the others are not alternates in the sense that they are substitutable. Even with all supplemental supplies developed to the optimum level, natural gas demand will probably exceed total supply for at least the remainder of the century. Since the DOMAC terminal is already operational, a discussion of alternate sites has not been made. The Everett terminal does meet the LNG terminal criteria and the Everett site appears to have been an acceptable choice for the facilities.

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9. CONCLUSIONS

The information elicited by the staff from field investigations, reference and source data, and special studies indicates that approval of the proposed importations of LNG, construction and operation of the LNG terminal and pipeline facilities, and the sale of natural gas would have no significant adverse impact directly on the environment under normal operating conditions.

However, the bulk handling of LNG does involve some risk to public health in terms of potential operational accidents. The risk associated with the operation of an import terminal occurs due to: (1) the transport of LNG on the ocean by ships; (2) the operation of large LNG vessels in confined harbors, including the docking of these vessels; (3) the unloading of the ships; and (4) the storage of LNG in the land-based tanks at the terminal, including the unloading of the tanks by smaller LNG carriers and pipeline transport of regasified methane.

The largest risk to public safety is believed to be associated with the harbor operation of oceangoing LNG ships. Not only is the likelihood of an accident greatest in the confined harbor area, but the ship is closer to larger numbers of the public. A major accident such as a ship collision and subsequent release of LNG must be recognized as possible, and the consequences of such an accident must be taken into consideration; however, it is considered to be unlikely. Operational safety measures being developed by the U.S. Coast Guard will further reduce the chance of such unlikely occurrences. It is concluded that the risk to the public from LNG ship operations in Boston Harbor is acceptable.

In order to minimize the adverse environmental impact of the proposed project and to promote its safe operation, it is recommended that the applicants perform the following tasks if this project is approved by the Commission:

-- Outline procedures to be utilized in the event that the evacuation of nearby areas and the suspension of local highway and shipping traffic are necessitated by a major accident. Such procedures should contain measures for the immediate notification of nearby inhabitants of any potentially dangerous situation that might arise and notification and mobilization of emergency personnel such as Civil Defense, hospitals,

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police and fire departments. Routes to be used by emergency personnel to reach the LNG terminal should be planned and test-driven. Such procedures should be outlined and the feasibility of implementing them within minutes of a large-scale spill or fire and/or potentially dangerous situation submitted to the Commission for review.

-- Confirm that the storage facilities will be operated by the procedures outlined in Section 4 regarding mixing and rollover, such that the problem of rollover is alleviated at the DOMAC facility.

-- Curtail LNG transfer operations during those periods when there is junkyard activity immediately adjacent to the LNG transfer line between the dock and terminal areas.

-- Provide adequate dike height, ditching, and land sloping, in combination, so that the maximum amount of LNG spilled in the event of an LNG transfer line failure between the dock and the diked tank area is contained within DOMAC property lines. The National Bureau of Standards has considered the potential magnitude of a spill from this transfer line to be on the order of 30,000 gallons, using the line capacities of the two marine unloading arms plus a portion of the amount of LNG remaining between shutoff valves.

It is recommended that the Commission require operational reports semiannually, within 45 days after each period ending December 31 and June 30, describing facility operations for the period covered and particularly noting any abnormal operating experiences or behavior. Abnormalities shall include, but not be limited to, rollover, geysering, cold spots on the tank, significant equipment malfunctions or failures, non-scheduled maintenance or repair (and reasons therefor), rapid vaporizations, vapor or liquid releases, negative pressures (vacuum) witnin the storage tank and higher than predicted boil-off rates. The technical information supplied by the applicant should be submitted in a form acceptable to the Commission and should be in sufficient detail to allow a complete understanding of such events consistent with the existing state-of-the-art or knowledge. Such information can

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provide the Federal Power Commission with useful technical data that may be applied to other LNG facilities. In the event that an abnormality is of sufficient magnitude to endanger the facility or operating personnel, the Commission should be notified immediately.

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APPENDIX A

Properties of LNG

Property	Value
Molecular Weight	16.04
Gas Gravity (air = 1.000)	0.555
Critical Temperature, °F	-116.5
°C	-82.5
Critical Pressure, psia	673.1
atmospheres	45.8
Liquid Gravity (water = 1.00)	0.44
Atmospheric Boiling Point,	
°F	-258.7
°C	-161.5
Liquid Density @BP, lb/cf	26.5
lb/gal.	3.53
gm/l	415
Gas Density @BP, lb/cf	0.11
gm/l	1.8
Gas Density @0°C, lb/cf	0.045
gm/l	0.72
Gas Density @STP, lb/cf	0.042
gm/l	0.68
Density = Air @STP, °F	-155
°C	-104
SCF gas/cf liquid @BP	630
/lb	24
/gal.	85
Heat of Vaporization,	
Btu/lb	220-248
cal/gm	122-138
Sensible Heat to 70°F, Btu/lb	166
cal/gm	93
Heat Content, Btu/lb	24,000
k-cal/gm	13.27
Spontaneous Ignition, °F	999
°C	537
Laminar Burning Vel. ft/sec	1.28
cm/sec	39
Minimum Ignition Energy,	
milli-joules	0.3
Fraction Combustion	
Heat Radiated	0.23
Flammable Range w/Air, %	5-15

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APPENDIX B

GENERAL AND SPECIFIC REQUIREMENTS FOR LNG/LPG OPERATIONS

A. PORT APPROVAL

1. All applicable U.S. Coast Guard requirements as set forth in Port Safety Regulations, Tank Vessel Regulations and instructions promulgated by Commandant, U. S. Coast Guard.

2. Assurance that all necessary approvals and conditions imposed by state and local agencies and departments are adhered to.

3. National Fire Protection Association, 60 Batterymarch Street, Boston, Massachusetts, should be consulted for any standards or recommendations they may offer.

4. Pre-arrival conference meeting consisting of all interested parties including Coast Guard, Shippers/ Importers, state and local authorities, including fire departments to establish and agree on emergency procedures and other matters.

B. VESSEL APPROVAL

1. Each Foreign Flag vessel concerned to be in possession of a valid Letter of Compliance for the carriage of the specific product to be loaded or discharged issued by Commandant, Coast Guard and all vessels to possess a Certificate of Financial Responsibility and be able to produce same upon demand.

a. Prior to the issuance of the Letter of Compliance, the vessel may be permitted to enter port to discharge cargo and be inspected for the issuance of Letter of Compliance. Since plan review and initial discussions have been handled by the Commandant, permission for initial entry should be by that office.

2. An arrival inspection by U. S. Coast Guard required prior to commencement by any discharge.

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C. OPERATIONS APPROVAL

1. The COTP and applicable state and local agencies shall be notified 72 hours in advance and again immediately prior to the arrival of vessel. In addition, cognizant COTP should be notified when first firm commitment is made to carry LNG/LPG into area.

2. Transfer of product at anchorage not permitted.

3. The vessel should, when operations permit, be Coast Guard escorted from the entrance of the port involved. In addition, a live tug must be immediately available during all cargo operations standing a designated radio guard. All inner harbor vessel movements to be under Coast Guard escort at discretion of COTP.

4. Vessel movements should be conducted under fair weather conditions with a minimum visibility to be determined by the cognizant COTP.

5. All areas are to be posted and restricted to essential personnel. Guards are to be posted to enforce regulations.

6. Issue Local Notice to Mariners establishing a "Safety Zone".

7. Prior to handling cargo, the shore piping which is to be used in the operation shall be checked for proper operation of automatic controls, gas detectors, and instrumentation. If any of the system contains air, it should be purged prior to handling product by an inert gas or in special circumstances using low pressure LPG or LNG vapor. Care shall be taken in purging to minimize the volume of flammable mixture cooled to prevent excessive thermal stress.

8. During cargo handling operations, gas shall not be vented in atmosphere. It is normal practice to utilize liquid and vapor connections in ship to shore transfer operations. Where the ship or barge is only delivering cargo, the vapor connection may be omitted if specifically approved. Care shall be taken that the discharge rate is slow enough under such conditions to prevent tank damage or vaporized product may have to be added to the tank.

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9. Ship's Master, Cargo Officer, or Supervisor designated by master to be aboard throughout entire discharge operations.

10. No other vessel activities in the immediate area or along involved waterfront facilities.

a. Operation of crew boat is authorized, however, crew boat may not moor alongside off-loading vessel and crew boat heater, if not electric, shall be secured when in vicinity of the off-loading vessel.

b. Special care must be shown when off-loading occurs at a general cargo pier.

11. All tank cars, tank trucks, and storage tanks shall be checked prior to loading to insure timeliness of their last test. Operability of overpressure protection devices should be verified.

12. Remote cargo transfer shutdowns to be listed and proven satisfactory.

13. Alarms shall be installed at waterside of pier ashore, as well as on the offshore mooring. Warning alarms shall be of the siren type or emergency rotating flashing light and of sufficient intensity to be seen or heard a distance of one (1) mile during normal facility working conditions. The alarm signal shall not conflict with local municipal prescription (33 CFR 126.16).

14. Commencement and termination of each transfer operation shall be monitored by the Coast Guard. The use of a Coast Guard vessel, when available, on scene at these times for communications, utilizing intrinsically safe communications equipment, is considered prudent.

15. No bunkering shall be conducted prior to or during the discharge operations.

16. COTP shall be advised in advance of the commencement and termination of the product transfer operations.

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17. The addition to portable equipment, the offshore mooring area of pier terminal area shall have any combination or semi-portable dry chemical extinguishers totaling 500 pounds. A fire main water source and spray equipment must be available as well.

18. Fire hoses shall be laid out and connected to hydrants in tank car and storage tank loading areas. The hydrants shall be tested for satisfactory flow prior to connecting hoses. International connections shall be available at ship and ashore.

19. Offshore and shoreside lighting, security and safety precautions shall be observed and ensured by the facility involved.

20. A qualified cryogenics supervisor shall be in attendance during all cargo operations.

21. In operations involving barges, a tankerman possessing an appropriate certificate for the product being handled shall be present during cargo operations.

22. No welding, burning, smoking, hot work, open lights, or similar activity are to be permitted during cargo operations.

a. At certain installations, normal hot work will be permitted in shops that are no closer than 200 feet to tank cars or storage tanks.

23. All cargo operations must cease if electrical storms are present.

24. All ships and shore personnel directly involved in cargo operations must readily speak and understand the English language.

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APPENDIX C

DEPARTMENT OF TRANSPORTATION

COAST GUARD

CAPTAIN OF THE PORT

Boston, Massachusetts

LNG/LPG CONTINGENCY PLAN

15 JUNE 1973

UNCLASSIFIED

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DEPARTMENT OF TRANSPORTATION
UNITED STATES COAST GUARD

MAILING ADDRESS:
Commander
CG GROUP BOSTON
427 Commercial St.
Boston, Mass. 02109

15 June 1973

LETTER OF PROMULGATION

1. PURPOSE: This plan promulgates policies governing Coast Guard actions concerning the transport and discharge of LNG and LPG in the Port of Boston, Massachusetts. In addition existing regulations and standing orders regarding LNG and LPG operations in Boston are included as appendices to this plan.

2. ACTION: All cognizant Coast Guard units shall insure that the requirements of this plan are met.

R. E. LYNCH
Captain
U. S. Coast Guard Reserve
Captain of the Port

DIST: COMDT (GW) (1)
(GM) (1)
(GCS) (1)
CCGD1 (dcs) (1)
(o) (2)
(m) (2)
(l) (1)
COTP BSN (15)
GRU BSN (5)
PSSTA BSN (15)
OCMI BSN (5)
OCMI PORTLAND (1)
OCMI PROVIDENCE (1)
GRU S. PORTLAND (1)
GRU SW HARBOR (1)
GRU WOODSHOLE (1)
MASS STATE POLICE (3)
MASS DEPT OF PUBLIC SAFETY (2)
MASS DEPT OF PUBLIC UTILITIES (2)
MASSPORT AUTHORITY (2)
MDC POLICE (2)
BSN FIRE DEPT (3)
BSN HARBORMASTER (2)

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DIST: BSN PLICE DEPT. (3)
EVERETT FIRE DEPT (2)
EVERETT POLICE DEPT (2)
CHELSEA FIRE DEPT (2)
CHELSEA POLICE DEPT (2)
WINTHROP FIRE DEPT (2)
WINTHROP POLICE DEPT (2)
DISTRIGAS CORPORATION, EVERETT, MASS. (2)
EXXON, EVERETT, MASS. (2)
BOSTON GAS COMMERCIAL POINT (2)
BOSTON GAS (EVERETT) (2)
BOSTON PILOTS (2)
BOSTON TOWBOATS (2)

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LNG/LPG CONTINGENCY PLAN

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	B. BOSTON GAS	
	C. EXXON	

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INTRODUCTION

The Port of Boston has led the country in developing procedures for the safe importation of LNG and LPG cargos. To further increase the safety of the importation of these cargos, this contingency plan has been developed. As more is learned regarding the hazardous properties of cryogenic liquified gases, changes will almost certainly be required in this plan.

Presently there are two LNG facilities in Boston Harbor which handle LNG (Liquid Natural Gas - methane). Boston Gas at Commercial Point, Dorchester, Mass., and Distrigas on the Mystic River, Everett, Mass., both have storage capabilities for LNG. LNG is transported and stored at -257 f. It is a flammable gas; is lighter than air, and in its liquid state it occupies approximately 1/600th of its volume as a gas. Its hazards are three: brittle fracture, flameless explosion, and an explosive vapor cloud. Brittle fracture may occur when LNG comes in contact with non-treated metal. Should it come into contact with water it results in instantaneous freezing and upon expansion it may cause an explosive type reaction, a flameless explosion. Many consider the most dangerous aspect of LNG the explosive vapor cloud that might be generated by a leak or spill. When this vapor cloud reaches a source of ignition a fire and/or explosion will occur, the size of which will be determined by the size of the explosive cloud.

The Exxon Everett facility receives and stores LPG (Liquified Propane Gas). LPG is transported and stored at -44 f; it is a flammable gas, which is heavier than air; and in its liquid state occupies approximately 1/250th of its volume as a gas. It is not likely that brittle fracture will occur should the liquid come into contact with untreated metal, but it is cold enough to damage human tissue. Additionally, it is flammable, and when exposed to a source of ignition, a fire and/or explosion will occur. It is particularly dangerous in that since the vapors are heavier than air they may tend to collect in pockets.

While industry and shipboard personnel are extremely safety conscious it is important that the various Federal, State and Local regulatory agencies act in unison concerning these liquids to further insure the safety of our port. The Captain of the Port has issued very specific requirements (see Appendix I) for vessels tran - itting the harbor and transferring cryogenic cargoes. The Coast Guard team consisting of Port Safety Station and Marine Inspection Office boarding officers and the men assigned to the escort and monitoring details are charged with the responsibility for insuring compliance with these regulations. The inspection procedures for the COTP/MIO boarding parties are outlined in Appendices III and IV.

Facility security is another important part of safe LNG/LPG operations. I urge all facilities handling these cryogenic liquids to review their security practices to further insure the safety of their facilities and ultimately of the Port of Boston.

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Our safety record to date is excellent. This is largely due to the complete co-operation of the Coast Guard; the facilities; the shippers; and other Federal, State and local regulatory agencies. A continuing program of complete safety consciousness will help to maintain this record and prevent any accident which may occur from becoming a disaster.

W. P. STEVENS
LCDR, U.S. Coast Guard
Alternate Captain of the Port
Boston, Massachusetts

D. H. BLOMBERG
LTJG, U.S. Coast Guard
Port Safety Officer
Port Safety Station
Boston, Massachusetts

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LNG/LPG CONTINGENCY PLAN

PHASE I - NOTIFICATION

1. Initial notification of the arrival of an LNG/LPG vessel is required in accordance with appendix I of this plan.

2. Upon notification of arrival, the Port Safety Officer, USCG Port Safety Station Boston, shall:

a. Insure that the vessel has a Letter of Compliance (see current Commandant Notice 5923).

b. Notify appropriate COTP, OCMI, and GROUP BOSTON personnel and keep them informed of all development

c. Maintain a daily update of vessel's estimated time of arrival.

d. Pass any unusual or additional information to the facility and ship's agents.

e. Arrange COTP and MIO boarding parties, escort detail, and monitoring detail.

3. The day prior to arrival the Port Safety Officer shall:

a. Request Notice to Mariners

b. Notify pilots of pending arrival and inform them of any special requirements affecting harbor transit (i.e. boarding party rendezvous at President Roads, anchorage permitted in harbor, etc.)

c. Notify the appropriate fire departments of times of transit of harbor and time and location of anchorage if permitted.

d. Notify harbormaster in accordance with b. and c. above.

e. Insure permit request has been made (Form 4260).

f. Update USCG Group/COTP/PSSTA Officer of the Day.

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PHASE II - ARRIVAL, DISCHARGE, DEPARTURE (NORMAL OPERATIONS)

1. Vessel will proceed in accordance with paragraph C(2) in Appendix I.

2. USCG Escort will be provided in accordance with Appendix II.

3. The escort vessel will provide the USCG GROUP/COTP/PSSTA Officer of the Day with the wind and weather conditions upon arriving on scene and keep him informed of any changes in conditions.

4. The escort vessel will transmit ops normal and position reports to the OOD every thirty (30) minutes.

5. The OOD will inform the appropriate fire departments, police departments, and the MASSPORT fireboat, RCC, and other cognizant organizations upon commencement of harbor transit in accordance with Appendix V.

6. The OOD shall determine the threatened sector of the harbor and/or city for initial entrance into harbor, each position reported by escort vessel, and the position of possible emergency should one occur (see PHASE III) in Acordance with Appendix VI. This information shall be corrected if changes in wind or weather conditions occur.

7. The OOD will inform those agencies listed in paragraph 5 above when the vessel is moored.

8. The USCG OCMI/COTP safety inspection will be conducted at the appropriate location and in accordance with Appendices I, III, and VI. The officer-in-charge of the inspection party shall:

a. Issue transfer permit upon successful completion of the inspection.

b. Remain on board until the transfer operation is progressing smoothly.

c. Pass instructions to the monitoring detail prior to departure.

d. Update the OOD concerning the situation and instruct him to keep appropriate personnel informed.

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9. The USCG will monitor the transfer operation in accordance with Appendix II. Upon completion of discharge (d.h. hoses disconnected) on scene monitoring will terminate. Prior to securing, monitoring personnel will inform OOD of vessel's ETD.

10. The vessel or agents will provide estimated time of departure. The vessel or agent is required to inform the USCG of any changes to this time of departure. The OOD will notify those agencies in paragraph 5 above of estimated time of departure.

11. Upon departure the USCG will provide an escort in accordance with Appendix II.

PHASE III - LNG/LPG EMERGENCY

1. The vessel is required to report any emergency to the USCG using any means available.

2. While moored, both the vessel and facility are required to notify the USCG of any emergency.

3. The escort vessel and the monitoring detail shall maintain alert watches for emergency situations and report these to the OOD immediately.

4. Possible emergencies that may occur are:

a. An incident (potential spill): equipment malfunction, diversion from planned route, grounding, or collision.

b. An actual spill.

5. For an incident the OOD shall:

a. Notify those agencies in paragraph 5, PHASE II and the COTP, the Deputy Group Commander, the Executive Officer of Port Safety Station Boston, the Port Safety Officer of PSSTA BOSTON of a potential spill and inform them of the threatened sector of the harbor and/or city in the event of a spill. The threatened sector will be determined in accordance with Appendix VI.

b. Dispatch the CGC PENDANT to the scene.

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c. Request that the Boston Fire Department and MASSPORT fireboats be dispatched to the scene if necessary.

d. Request commercial tug assistance if necessary.

e. Ascertain if the appropriate Fire and Police departments are preparing to evacuate the threatened sector of the city.

f. Provide small boat(s) for water traffic control.

g. Permit no vessel movemments in the harbor which will interfere with the resolution of the emergency.

h. Assume OSC until relieved by appropriate authority.

6. In the event of an actual spill the OOD shall:

a. Proceed as in paragraph 5 above.

b. Direct on scene units to apply high velocity fog on the leak from an upwind position.

c. Issue an emergency broadcast to all ships.

d. Permit no vessel movements in the harbor other than those required to control the emergency.

e. Assist the vessel and/or the facility in stopping the leak.

f. Should a fire occur, yield firefighting control to the fire department on scene.

7. Further information on the control of LNG/LPG emergencies is contained in Appendix VII.

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APPENDIX I

U. S. COAST GUARD CAPTAIN OF THE PORT
BOSTON, MASS.
GENERAL REGULATIONS FOR
THE TRANSPORT AND DISCHARGE OF
LNG/LPG

1. In the past, as Captain of the Port of Boston, I have issued specific instructions for each LNG/LPG vessel transit and cargo transfer operation within the Port of Boston. The frequency of these operations and the experience gleaned from past operations now make it possible to issue a standardized set of regulations for future operations.

2. In the interest of port safety, I, my staff and personnel from the Boston Marine Inspection Office will continuously monitor all LNG/LPG vessel transits and cargo transfer operations within the port of Boston. I consider it prudent to impose the following restrictions, in addition to all applicable local, state and federal regulations:

a. the facility and/or the vessel's agents must:

(1) notify the COTP and all applicable state and local agencies at least 72 hours in advance of the vessels arrival and again immediately prior to the arrival of the vessel.

(2) submit an Application and Permit to Handle Explosives or Other Dangerous Cargo (Coast Guard form 4260) prior to the arrival of the vessel .

(3) insure that bunkering operations are not conducted prior to and during LNG/LPG discharge operations .

(4) insure that during periods of cargo transfer the facility shall have one man on board the vessel and one man in the control center who shall be able to communicate with each other at all times.

(5) insure that no other cargo transfer operations or vessel movements are permitted at the facility during discharge operations.

(6) insure that no welding, burning, hotwork, smoking, open lights or similar acitivities are permitted while the vessel is alongside.

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b. The vessel must:

(1) Hold a current Letter of Compliance for the carriage of methane/propane issued by the Commanddant and a Certificate of Financial Responsibility for Oil Pollution

(2) Enter the harbor only during daylight hours. Additionally, vessels transitting Dorchester may only do so within two (02) hours of high water. Weather permitting, the COTP may authorize night departures.

(3) Enter the harbor only during periods of good visibility.. If the visibility is less than two miles the vessel must:

(i) If at sea, do not enter port without the COTP's permission

(ii) If in port, notify COTP of position and then proceed to berth or anchorage, whichever nearer.

(4) Maintain a radio guard on Channel 13 (156.65 mhz) while underway in the port area. Additionally, if possible, a guard should also be maintained on Channel 16 (156.8 mhz).

(5) Not commence offloading cargo prior to the satisfactory completion of the arrival safety inspection by Coast Guard Marine Inspectors and the issuance of the Permit to Handle Explosives or Other Dangerous Cargo (C.G. Form 4260)

c. Additionally:

(1) The vessel must moor either bow to seaward and be prepared to get underway on short notice, should an emergency so require, or have a live tug standing by during all cargo operations. A live tug standby will be required on a vessel's first visit to this port.

(2) The vessel will normally be boarded while anchored in PRESIDENT ROADS by COTP/OCMI inspectors unless, prior to the vessels arrival, the master sends a message to COTP stating that:

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"To the best of my knowledge and belief there are no known casualties to this vessel or its machinery which might affect the seaworthiness. I further state that all cyrogenic handling and detection equipment is in proper operating condition."

If this message has been received, the inspection will be made at the dock unless it is the vessels first visit to Boston. On a vessel's first visit to Boston the boarding will always be made in President Roads. If the vessel does not hold a Letter of Compliance the boarding will be made in BROAD SOUND and the vessel will not be allowed to enter the port until a temporary Letter of Compliance is issued.

(3) Venting gas to the atmosphere is not permitted in port

(4) All cargo operations must cease if electrical storms are present

(5) If interpreters are not available, all ship's personnel directly involved in the transfer operation shall readily speak the English Language

3. Should conditions so require, the above restrictions may either be amended or additional restrictions may be imposed by the Captain of the Port. If there are any questions concerning the above, please contact the Coast Guard COTP. The Port of Boston has led the country in developing procedures for the safe importation of LNG cargoes. Your continuing co-operation in the safe handling of LNG and LPG cargos to insure the safety of our port is appreciated.

H. L. LYNCH
Captain, U. S. Coast Guard Reserve
Captain of the Port
United States Coast Guard
Boston, Massachusetts

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APPENDIX II

Standing Orders for LNG/LPG Vessel Escort and Monitoring Details

1. Port Safety Station Boston is responsible for escorting LNG and LPG vessels through Boston Inner Harbor upon their arrival and departure and monitoring their offloading operations. As the Coast Guard has listed these cargoes among those designated as "cargoes of particular hazard" it is extremely important that the personnel involved in these escort and monitoring missions understand both the potential hazards involved and the necessity that a "tight watch" be maintained.

2. The duties of the escort and monitoring details are as follows:

A. ESCORT CRAFT

1. Escort duties may be assigned to either the Pendant, the 46301, a 40'UTB, or a 31'PSB. Normally a 40'UTB will be assigned to this duty.

2. The escort will commence at Deer Island for the inbound transit and terminate there for the outbound transit.

3. A Notice to Mariners will have been issued prior to the ship's arrival cautioning all mariners to stand clear of the LNG/LPG carrier. It is the duty of the escort craft to insure compliance with this. Other tankers or freighters should not be a problem as the pilots communicate with each other, however the coxswain must exercise care that private vessels, tugs with barges, and naval or C.G. ships do not endanger the LNG/LPG carrier. Under all circumstances, insure that the escort craft does not interfere with the carrier.

4. Normally the escort craft should take station several hundred yards ahead of the vessel and precede her through the harbor.

5. Should an emergency situation occur aboard the vessel (grounding, fire, loss of steering, etc.) the coxswain shall immediately notify the communications center so that a contingency plan can be activated to handle the emergency. The escort craft will then provide traffic control to keep all vessels clear of the ship other than tugs, fireboats, etc. It is most important that unauthorized craft be kept clear of the LNG/LPG vessels down wind side.

6. Communications with the vessel may be established on channels 6, 13, and/or 16FM. Communications with other rescue craft will be on Channel 6 or 16FM.

7. The arrival escort will terminate upon release by the boarding party. The departure escort will terminate at Deer Island.

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8. A Notice to Mariners is not published for the vessels departure, however, the escort vessel shall still keep "sight-seers" clear of the vessel.

B. MONITORING DETAIL

1. The monitoring detail will be composed of personnel from the Port Safety Office, the 46301, the PENDANT, and occasionally C.G. Reservists.

2. When the COTP/MIO boarding personnel depart ,the monitoring detail will be informed of any unusual conditions aboard the facility or the vessel.

3. If the monitoring detail is not aboard the PENDANT, or the 46301, arrangements will be made for use of the dockside watch shack.

4. If a boat is used, it shall be moored upwind from the vessel if possible.

5. The monitoring detail shall keep abreast of the transfer operation and report "ops normal" to the communications center at least every two hours. Should an emergency situation occur (fire aboard the vessel or facility, hose or pipe break etc.) the communications center shall be informed immediately so that the proper personnel may be recalled and the emergency contingency plan activated. If a leak occurs and the PENDANT is the monitoring detail, initial action, after notifying the Communications center, should be to attempt to spray the leak with high velocity fog.

6. The monitoring detail may secure when the transfer operation is completed and the hose connection brcken.

7. The Port of Boston leads the country in the importation of super-cold liquids. Our safety record to date is excellent. This is largely due to the complete cooperation between the Coast Guard, the facilities, the shippers, and other Federal, State and local regulatory agencies. A continuing program of complete safety consciousness will help to maintain this record and prevent any accident which does occur from becoming a disaster.

H. P. LYNCH
Captain, U. S. Coast Guard Reserve
Captain of the Port
Boston, Massachusetts

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APPENDIX III

SAFETY INSPECTION FOR FOREIGN VESSELS CARRYING BULK CARGO OF UNUSUAL RISK

MIO BOSTON

LIQUIFIED FLAMMABLE GASSES

VESSEL NAME_____ NATIONALITY_____

GROSS TONS_____ DATE OF INSPECTION_____

EXPIRATION DATE: CARGO SAFETY EQUIPMENT CERTIFICATE_____

EXPIRATION DATE: CARGO SHIP SAFETY CONSTRUCTION CERTIFICATE

_____

CERTIFICATE OF FINANCIAL RESPONSIBILITY FROM FED. MARITIME COMMISSION _____

DATE: LOAD LINE_____

OWNER: NAME_____ ADDRESS_____

AGENT: NAME_____ ADDRESS_____

CARGO: _____

1. LETTER OF COMPLIANCE. DATED_____ _____
(SEE COMDT NOTE 5923)

2. CARGO TANKS AND CARGO PIPING RELIEF VALVES SET AND SEALED BY CLASSIFICATION SOCIETY OR SAFETY ADMINSTRATION WITH CERTIFICATION OF SET POINT ABOARD_____ _____
IF VALVES NOT SEALED SUITABLE OFFICIAL RECORDS AVAILABLE TO DETERMINE NO CHANGE BY SHIP OF SET PRESSURE_____

3. CHECK OF CARGO LEAK DETECTION SYSTEM (READOUTS MADE ALL SENSING POINTS) INSTRUMENT SCALE_____ _____
LNG 5.0% LNG 15%
PRODUCT CARRIED LEL LPG 2.4% UEL LPG 9.5%

UNUSUAL READINGS NOTED: AMOUNT_____
LOCATIONS_____

DO ALARMS (AUDIBLE AND VISUAL) FUNCTION _____
SET POINT FOR ALARM_____
FREQUENCY OF READINGS PRIOR TO U.S. PORT ENTRY_____

4. CARGO AND SECONDARY BARRIER (IF INSTALLED) AND VOID SPACE TEMPERATURE SENSING SYSTEM FREQUENCY OF READINGS WITH CARGO ON BOARD PRIOR TO ENTRY U.S. PORT_____

CHECK MADE OF ALL SENSING POINTS UNUSUAL TEMPERATURES NOTED:_____

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5. REMOTE SHUT DOWN OF AUTOMATIC CARGO VALVES
REMOTE SHUT DOWN OF CARGO PUMPS
TESTED FROM ALL CONTROL STATIONS_____ _____

6. VESSEL ELECTRICALLY BONDED TO SHORE CARGO SYSTEM

_____

7. DRIP PANS OR OTHER HULL PROTECTION IN PLACE UNDER CONNECTION OF VESSEL CARGO SYSTEM TO SHORE_____

8. ELECTRICAL EQUIPMENT AND LIGHTING IN HAZARDOUS LOCATIONS CHECKED. FIXTURES INTACT, EXPLOSION PROOF_____

9. FIRE FIGHTING EQUIPMENT AVAILABLE AND IN PLACE READY FOR USE_____

10. INTERNATIONAL SHORE CONNECTION_____

11. WARNING SIGNS IN PLACE_____ _____

12. COMMUNICATIONS ESTABLISHED SHIP TO SHORE_____
AND CONTROL OF OPERATIONS ESTABLISHED_____

VESSEL PERSONNEL HAVE ADEQUATE KNOWLEDGE OF ENGLISH AND APPEAR KNOWLEDGEABLE IN SHIP CARGO OPERATIONS_____

CARGO LINE COOL DOWN CARRIED OUT PROPERLY_____ _____

REMARKS:

_____
(MARINE INSPECTOR)

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APPENDIX IV

LNG/LPG Ship Arrival Inspection For Letter Of Compliance (MIO BOSTON)

GENERAL

1. Operations - discuss method of cool down; discuss communication between ship/terminal, watches, personnel. Be assured that ship-terminal have reached agreement on procedures. Do key personnel have proper proficiency in the English language?

2. Check of cargo related instrumentation systems for gas detection, temperature and pressure indication. Unusual low temperatures are cause for concern. Use of LFG (butane OK) introduced into system to check alarms if possible. Alarm set at 30% LEL. Each point to be checked every 30 minutes or less. Check status of tank pressures, rate of increase in tanks if pressure rise noted.

3. Status of Void spaces and Secondary Barrier Spaces (if installed) - Check monitoring logs of voids, secondary barrier spaces; monitor concentrations of inerted spaces.

4. Fire protection - Check all installed systems. Equipment and operability. Systems should match approved plans. International shore connections provided.

5. Warning signs posted at terminal and ship.

6. Proper electrical grounding to terminal.

7. Check of conventional Certificates of vessel (SOLAS, Loadline, Financial responsibility).

8. Liquid level systems; operability and if as approved.

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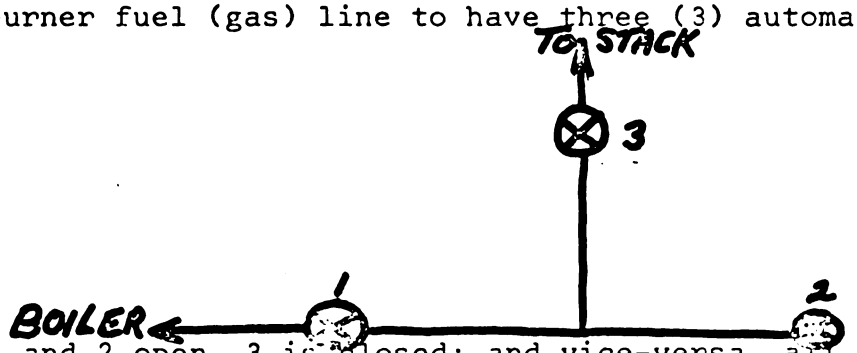
BOILER (If installed)

1. Check supply of gas and fuel oil. Gas in double wall piping or ventilated duct. If double wall piping, pressure between walls to be higher than that of fuel (gas). Alarms to indicate pressure drop. Pressure to be indicated. If not pressurised, then gas detection system to indicate leaks is required.

   If positively ventilated duct - two (2) alarms (one at low, one higher at same % of LEL) when high operates, fuel to burners is shut off. Blower for dust interlocked so that fuel supply valves cannot operate unless blower running. All shut when blower stops.

2. Hood for boiler front - ventilation air sweep across fuel fittings - gas detectors. If air not flowing, fuel (gas) shut off.

3. Each burner fuel (gas) line to have three (3) automatic valves:



   when 1 and 2 open, 3 is closed; and vice-versa, all automatic.

4. Master line valve in methane system located outside ER. This valve to close automatically; if leak detected, if ventilation blower stops, or, if no ventilating air.

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LNG/LPG Ship Arrival Inspection For Letter Of Compliance (MIO Boston)

MECHANICAL

1. Check piping runs, number of flanges, drip protection, expansion joints. Class II L systems-slip-ons limited to 4", sockets to 3". Plate type slip-ons not permitted.

   Class I L systems - all but weld type flanges and connection required.

2. Check product and related system pressure vessels. Note approvals (stamped on vessels or certificates). Note relief devices and settings. Note whether each pressure vessel is listed on approved system diagram.

3. Tank safety valves - Note setting, proper sealing (or equivalent), and records. Secondary barrier and other void spaces - pressure relief devices to be checked.

4. Check and operate all quick closing tank valves; check fusible elements.

5. Check gaging systems; liquid level; hi alarm; low liquid level alarm.

6. Means of pumping out tanks. Check for two methods on non-pressure vessel tanks. Means of pumping out voids available. Check operation of cargo pumps from remote shutdown points.

7. Vacuum protection of cargo tanks. Discuss with ship personnel how protection achieved, i.e., pump shut downs, introduction of vapor, etc.

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ELECTRICAL AND VENTING

1. Check all hazardous areas: Deck/compartments - are motors, lights, and other electrical equipment explosion proof? Is equipment identifiable on name plates? Class I, division 1 standards or equivalent are required. Use of gas-locks to make compartment non-hazardous, not approved.

   Compressor rooms. Thru runs of cable not permitted, switches located outside space, lights explosion proof. SEE 38.15-15.

2. Check penetrations and seals of cables, shafts, tubing from hazardous to non hazardous areas.

3. Cargo handling spaces should be ventilated by exhaust type fans. Check non-sparking properties and flow of ventilating air.

4. Check intrinsically safe equipment. Identification.

5. Check cable runs for proper installation (tight bends, type, damage, etc.).

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APPENDIX V

COMMUNICATIONS

1. Paragraph a outlines procedures for routine communications and notifications pertaining to LNG/LPG vessel arrivals and departures. Paragraph b, lists those marine radio frequencies on board vessels which may be called on to respond to an LNG/LPG/SNG emergency and paragraph c is a listing of names and phone numbers of organizations concerned with transit and transfer operations and capable of responding to an LNG/LPG/SNG incident.

a. The below listed agencies will be notified by the Coast Guard prior to and at the completion of each LNG/LPG vessel transit.

Boston Fire Department -442 8000 (Chief Reynolds)
Boston Harbormaster - 536 5700 (District 1 LT GIBBONS)
MASSPORT Fire Dept. 569-6864
*Everett Fire Department -387-5045 (Chief Butler)
*Everett Police Department - 387 1212 (Desk Sargent)

* Asterisked agencies need not be notified for Commercial point arrivals.

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B. **The following agencies and companies have the below listed Marine Radio frequencies which are available to be utilized. Should an incident occur, Channel 6 FM (156.3mhz) is to be utilized as the working frequency for participating units. Under normal operating conditions, marine units will be guarding Channel 13 FM (156.65mhz) or Channel 16 FM (156.8mhz).**

Frequencies (mhz)	Bsn Fire Dept. 33.74	Bsn Fire Dept. 44.74	Bsn Fire Dept. 153.89	Newton Control 154.22	Channel 6 Intership Safety 156.3	Channel 10 Commercial 156.5	Channel 11 Commercial 156.55	Channel 12 Port Operations 156.6	Channel 13 Navigational 156.65	Channel 14 Port Operations 156.7	Channel 16 Distress, Safety, & Calling 156.8	Channel 22 Coast Guard 157.1	Channel 23 Coast Guard 157.15	Logan Rescue 453
Boston Fire Boats														
Eng 47 (Firefighter)	X		X		X						X			
Eng 31	X		X		X						X			
Massport Fire Boat														
Howard Fitzpatrick	X			X	X	X			X	X	X		X	X
Boston Towboats														
Shore Station					X	X	X		X		X			
Walton					X	X	X		X		X			
Mars					X	X			X		X			
Orion					X	X			X		X			
Triton					X	X			X		X			
Athena					X	X			X		X			
Daley					X	X	X		X		X			
Cabot					X	X	X		X		X			
Boston Pilots														
Shore Station						X					X			
Boston Pilot					X	X			X		X	X		

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Frequencies (mhz)	33.74	44.74	153.89	154.22	156.3	156.5	156.55	156.6	156.65	156.7	156.8	157.1	157.15	458.85
	Bsn Fire Dept.	Bsn Fire Dept.	Bsn Fire Dept.	Newton Control	Channel 6 Intership Safety	Channel 10 Commercial	Channel 11 Commercial	Channel 12 Port Operations	Channel 13 Navigational	Channel 14 Port Opertions	Channel 16 Distress, Safety,& Calling	Channel 22 Coast Guard	Channel 23 Coast Guard	Logan Rescue
Distrigas Corp.														
Shore Unit (KGD576)					X	X			X		X			
Tug Amy Moran (WZF3006)					X	X	X	X	X	X	X			
Exxon														
Exxon Bay State					X	X	X		X					
Coast Guard														
Shore Station														
(Group Boston)					X			X	X		X	X	X	
Tug Pendant					X			X	X		X	X	X	
CG 46301					X			X	X	X	X	X	X	
CG 40538					X			X	X	X	X	X	X	
CG 40568					X			X	X	X	X	X	X	
CG 31022					X			X	X		X	X	X	
CG 31023					X			X	X		X	X	X	
Portable Units					X				X		X	X	X	

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c. The following agencies and companies may be involved in a LNG/LPG incident and their phone numbers (all 24 hours a day numbers) are listed below:

FEDERAL AGENCIES

U. S. Coast Guard
COTP Boston - 223-6977
Port Safety Office 223-6977
Duty Officer 223-6978

STATE AGENCIES

Mass. State Police
Troop F (Logan Airport) 567-2233
Communications Department, LT John J. MUPHY 566-4500
Mass. Department of Public Safety, Mr. J. Olsen 566-4500
Mass. Dept. of Public Utilities
Mr. J. NEE - 727-3535 (working hours)
698-0864 (home phone)

MASSPORT AUTHORITY

Massport Fire Dept.
Office - 482-2930 ext 208
fireboat "Howard Fitzpatrick" - 569-6864

LOCAL AGENCIES

MDC Police 523-1212
Boston -
Fire Dept. - 911 or 536-1500
Police Dept. - 911 or 338-1212
Everett
Fire Dept. - 387-0018
Police Dept. - 387-1212
Chelsea
Fire Dept. - 884-1410
Police Dept. - 884-1212
Winthrop
Fire Dept. - 846-3473
Police Dept. - 846-1212

FACILITIES

LNG:
DISTRIGAS Corp. 389-7910
Boston Gas (Commercial Pt.) - 288-3820
LPG:
EXXON - 389-7400
SNG:
Boston Gas (Everett) - 389-6111

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OTHER

Boston Pilots -227-3575
Boston Towboats - 227-7721

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PREFACE TO APPENDIX VI

The information contained in Appendix VI has been obtained from Arthur D. Little, Inc., Cambridge, Massachusetts. Arthur D. Little, Inc. is developing the Chemical Hazardous Response Information System (CHRIS) for the United States Coast Guard.

When CHRIS is fully developed, it will replace Appendix VI.

In using Appendix VI, the OOD should assume (unless other information is available) that 10,000 tons (approximately one tank) of product has been spilled. In assessing the atmospheric condition type (table 2), use the worst condition if any doubt exists. In determining the duration of the vapor cloud danger for a continuous spill, add the duration of chemical release to the duration calculated for an instantaneous spill, if the release time is appreciable.

For Example:

The OOD receives word that an LNG vessel has grounded and one tank has developed a continuous leak - rate unknown. The time is 1200; the wind is 8 knots from the NE; it is mostly sunny (i.e. moderate incoming solar radiation). The information that the OOD should obtain from Appendix VI is:

1. Liquified pool radius: 1,120 ft.
2. Time for complete evaporation of Pool: 4 minutes plus the duration of the leak
3. Atmospheric condition type : C
4. Maximum extent of flammable cloud: 0.45 nautical miles
5. Maximum half-width of flammable vapor cloud: 1,050 ft.
6. Safe separation distance for woodlike structures: 1,800 ft. from pool center (or from center of vapor cloud)
7. Duration of hazard from vapor cloud: $\frac{0.45}{8} = 0.056$ hours

   or 0.06 hrs
   or 3.6 min.
   plus the duration of the leak

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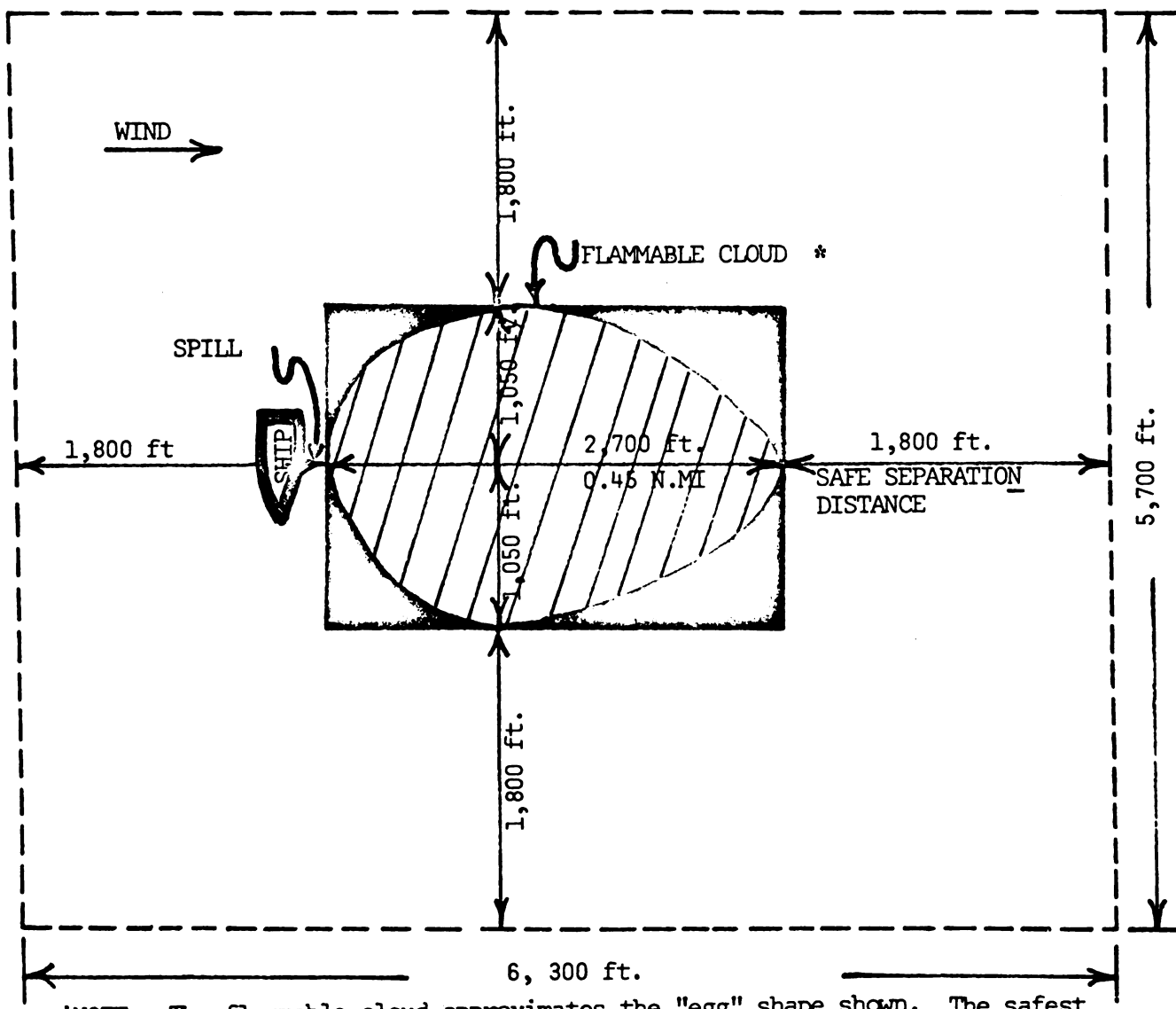
8. Diagram of area effected:



*NOTE: The flammable cloud approximates the "egg" shape shown. The safest course would be to construct a rectangle as shown in black.

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The table below is useful in understanding the hazards and reactions of LNG and LPG as compared to gasoline.

	LNG METHANE	LPG PROPANE	GASOLINE
46 CFR "N" CLASS	COMPRESSED GAS	COMPRESSED GAS	FLAMMABLE LIQUID
CHEMICAL FORMULA	CH_4	C_3H_8	C_5H_{12} (HEXANE) C_6H_{14} (PENTANE)
BOILING POINT @ 1 ATM (°F)	-258	-44	MIXTURE Between 95-300
DENSITY LIQUID H_2O=1	0.42	0.51	0.70
DENSITY VAPOR AIR=1	0.554 @ -1559 1.0	1.547	3.0 4.0
VOLUME/VOLUME LIQUID	618	268	130 or less
LEL %	5.0	2.4	1.4
UEL %	15.0	9.5	7.6
SPONTANEOUS IGNITION TEMPERATURE (°F)	999	871	495

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APPENDIX VI

ASSESSMENT OF HAZARDS DUE TO SPILLS OF LNG AND LPG ON WATER

INTRODUCTION

Both LNG and LPG are shipped in bulk quantities as liquids whose boiling temperature is well below that of water. Further, both liquids are lighter than water. When either liquid is spilled on water it tends to spread while simultaneously evaporating and generating flammable vapors. The flammable vapors can be carried for great distances (depending on the atmospheric conditions) and may ignite at distances for from the spill site itself. On the other hand, immediate ignition of the spill will result in an intense, short-duration fire in the vicinity of the spill site.

In order to develop safe operating procedures for the shipment and unloading of LNG and LPG it is instructive to understand the hazards presented by accidental spills of these chemicals on water.

SPREAD AND MOVEMENT

Consider the case of an instantaneous release of the chemical (LNG or LPG) on water. It will spread on the surface of the water while evaporating rapidly. The maximum spill radius achieved and the time taken for total evaporation is very small, less than 10 minutes. If a pool fire were to result during the spill, the fire duration would be approximated by the pool duration times given in Table 1 (b) and the fire size would be approximated by the maximum pool radius given in Table 1 (a) for various spill amounts. For purposes of estimating total vapor travel distances, the vapor release may be considered instantaneous, originating from a source of radius equal to the maximum pool radius.

VAPOR DISPERSION

In the absence of early ignition during the spill, a vapor cloud will be generated due to the spill. As this cloud disperses in air under the existing atmospheric

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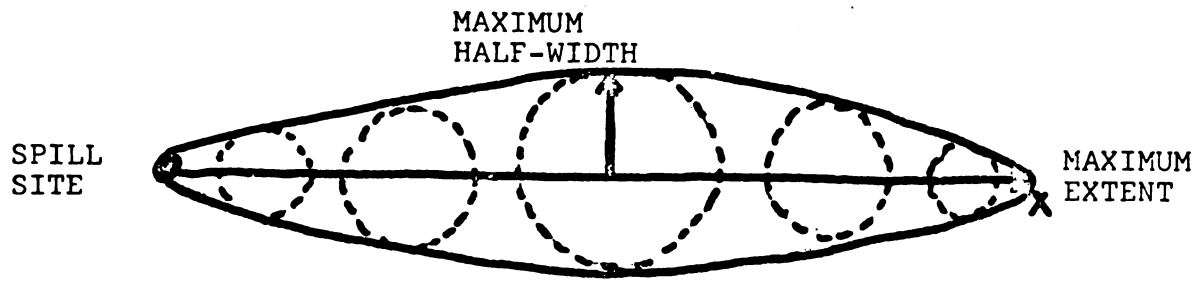
conditions it is useful to determine the distance of travel over which the cloud remains flammable. Schematically, the plan view of the flammable vapor cloud looks as shown below. The tear shaped envelope is a time history of the growth and total dispersal of the cloud and does not represent the instantaneous hazard zone. The dotted circles represent the instantaneous hazard zones at various times. The distances representing maximum extent and maximum half-width are identified in the schematic. Note that the maximum half-width dimension refers to the largest flammable portion



WIND BLOWING FROM LEFT TO RIGHT
BEYOND POINT X THE VAPOR CONCENTRATION IN THE CLOUD IS BELOW THE LOWER FLAMMABLE LIGHT

of the cloud and occurs at downwind distances less than the maximum extent of hazard.

Figures 1 and 2 present the maximum extent and the maximum half-width of the flammable vapor cloud due to various quantities of LNG spilled. Figures 3 and 4 are similar figures for LPG. Note that these four graphs have several (4) lines eaeh designated by letters C, D, E, and F. These refer to atmospheric conditions as defined in Table 2. In case of doubt regarding the real weather condition, an estimate of hazard based on condition F will provide the most severe estimate.

The total duration of hazard from a spill can be calculated simply by dividing the maximum extent by the wind speed. If the maximum extent for a particular case were 2 miles with a wind speed of 5 knots, the hazard duration would be estimated as 2 ÷ 0.4 hours = 24 minutes.

POOL FIRE HAZARD

In the event of early ignition and a resulting pool fire it is important not to let other ships and barges to get too close to the fire. The safe separation distance for wooden

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materials from the fire center is given in Figure 5 for pool fires of various sizes. Figure 5 applies equally well to LNG and LPG and uses the maximum pool radius given in Table 1 as an input. The maximum duration of such a fire can be approximated by the time for evaporation listed in Table 1 also.

DISCUSSION

The hazard assessment presented in this note is strictly for instantaneous discharges of LNG and LPG. In any real situation the spill may occur over several minutes or even an hour. Naturally, if the release time is large, the duration of hazard is correspondingly increased. Estimates of hazard zone extent for continuous releases of LNG and LPG can be made but would require rate of release of chemical as an input. In any practical situation it will not be possible to estimate the rate of release in an accident.

For purposes of quick hazard assessment it is advisable to assume that an entire tank of chemical is released instantaneously and use this to determine maximum vapor travel and cloud width dimensions and maximum fire size. As far as duration of hazard is concerned, it may be estimated conservatively as the sum of the duration as calculated for instantaneous spills and the duration of chemical release, should the release time be appreciable.

It is important to realize that if a vapor cloud is carried into densely populated areas by the prevailing wind its chances of being immdiately ignited before it penetrates far in the populated areas is very high. A methane vapor cloud is generally quite ignitable at its leading edge where the methane concentration is within the flammable range of 5% and 15%. In any populated area there are several types of ignition sources: people, their domestic appliances, private endustrial operations, public works, and other related facilities. People smoke- i.e. light cigarettes, cigars, and pipes. Cooking appliances have pilot lights that can act as ignition sources. Sparks from AC/DC motors, outdoor grills, pilot lights in heating units, and automobiles are also possible ignition sources. In addition, industrial operations can involve welding, fired boilers, grinding of metals and open flames, any one of which can ignite a methane

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cloud. The number of these and other sources is so large that ignition of the cloud within a short time after it reaches a populated place is a virtual certainty. It may then be concluded that in the remote event that a large spill occurs and a vapor cloud does travel into a highly populated area early ignition will undoubtedly occur and result in far less damage than deep penetration into populated areas prior to ignition.

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Table 1

Table 1a Maximum Radius of Pool for Various Spill Amounts

LNG	
Spill Quantity (Tons)	Maximum Radius (Feet)
50	150
100	200
300	300
500	360
1,000	470
3,000	710
5,000	860
10,000	1,120

LPG	
Spill Quantity (Tons)	Maximum Radius (Feet)
50	160
100	210
300	320
500	390
1,000	510
3,000	770
5,000	940
10,000	1,230

Table 1b Time for Complete Evaporation of Pool

LNG	
Spill Quantity (Tons)	Time For Evaporation (Seconds)
50	64
100	76
300	100
500	110
1,000	140
3,000	180
5,000	200
10,000	240

LPG	
Spill Quantity (Tons)	Time for Evaporation (Seconds)
50	120
100	140
300	190
500	220
1,000	260
3,000	340
5,000	380
10,000	450

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Table 2

Key to Atmospheric Condition Type to be Used in Vapor Dispersion Calculations

Surface Wind Speed (at 35 ft.)	Day			Night	
	Incoming Solar Radiation			Thinly Overcast or	
Knots	Strong	Moderate	Slight	≥ 4/8 Low Cloud	≤ 3/8 Cloud
< 4	A	A-B	B		
4-6	A-B	B	C	E	F
6-10	B	B-C	C	D	E
10-12	C	C-D	D	D	D
> 12	C	D	D	D	D

The neutral class, D, should be assumed for overcast conditions during day or night.

Type A and B atmospheric conditions cause rapid dispersion of the vapor cloud and are not treated in the hazard assessment Graphs 1, 2, 3, and 4.

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Figure 1

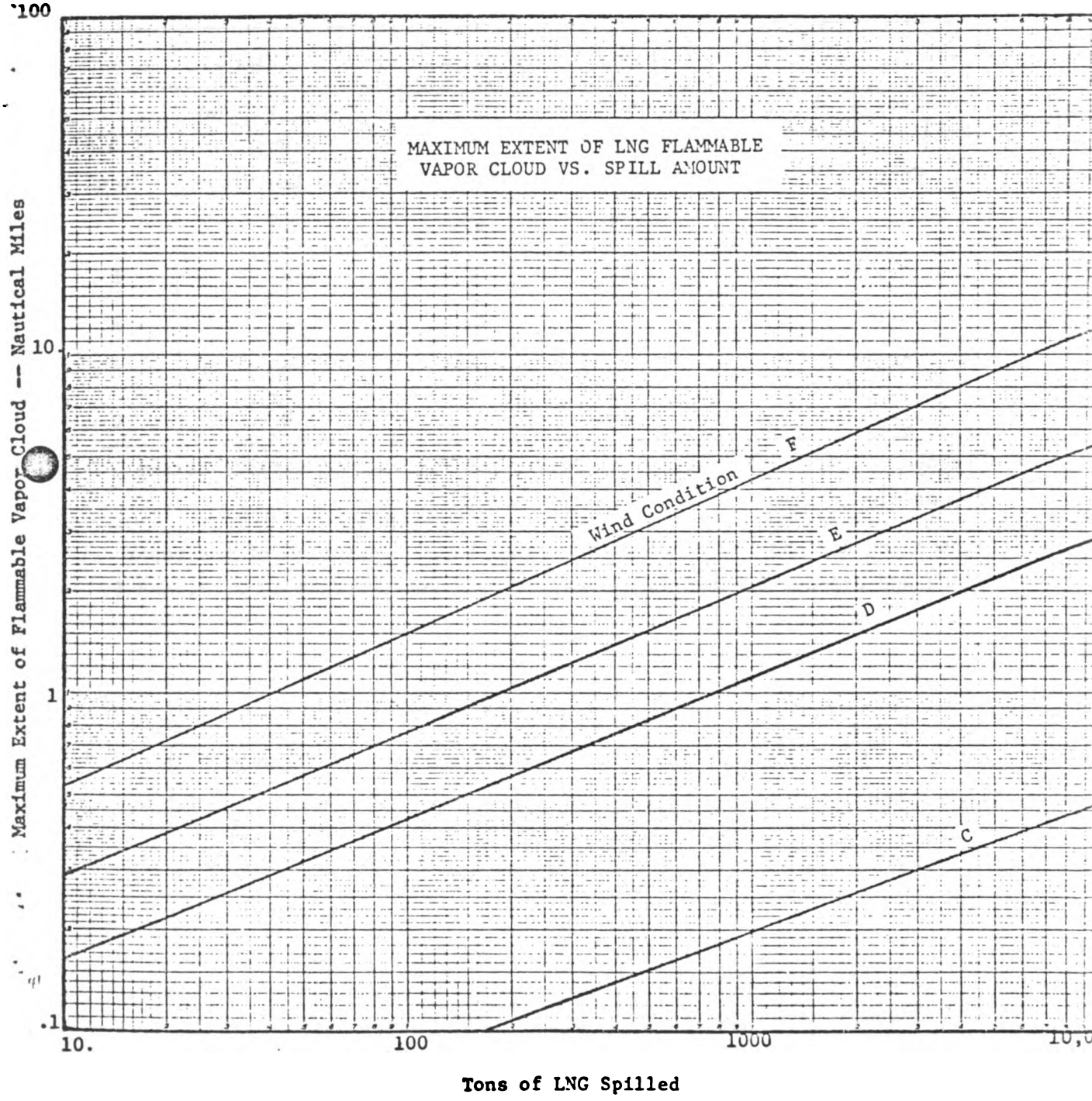

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Figure 2

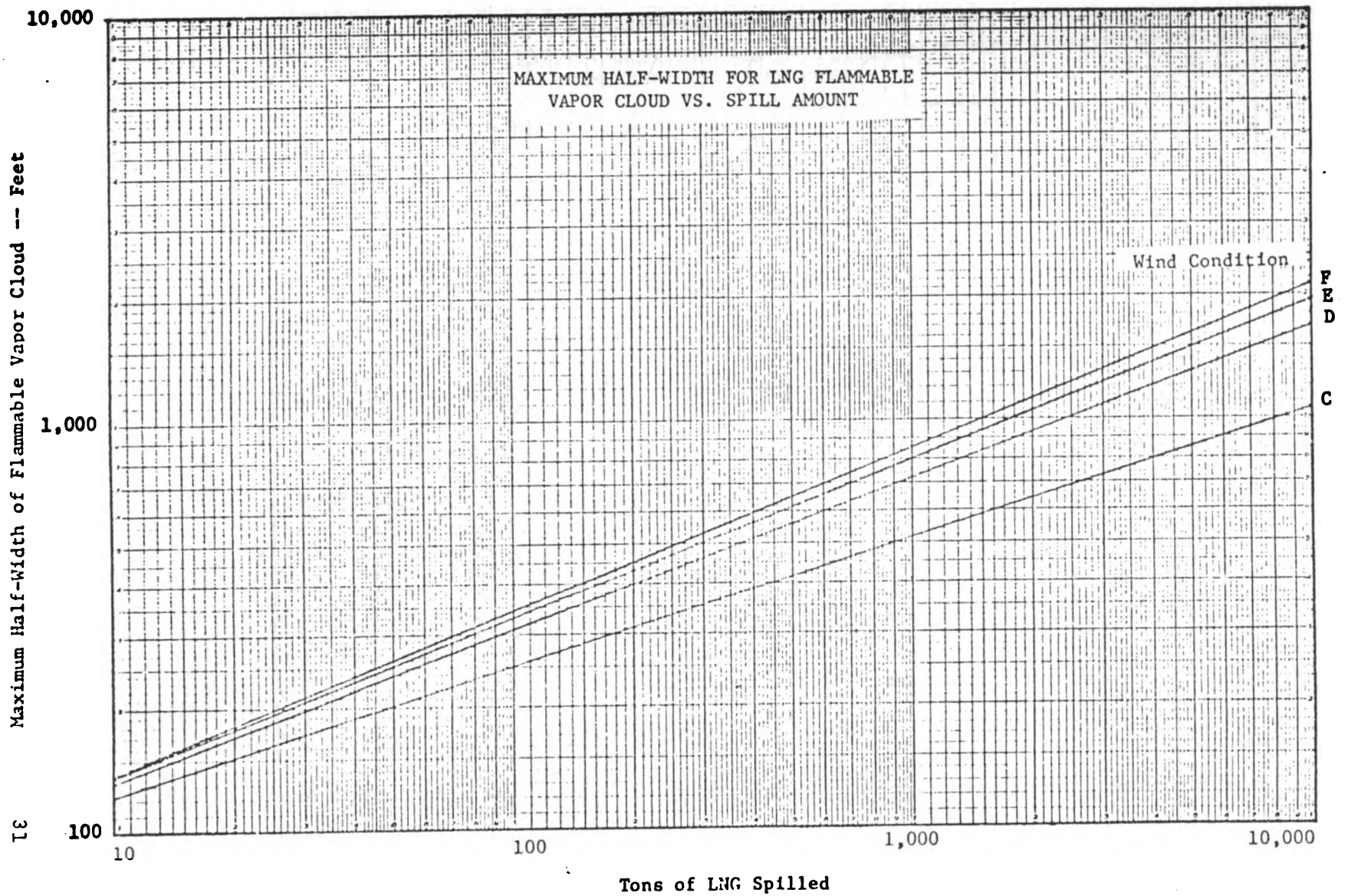

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Figure 3

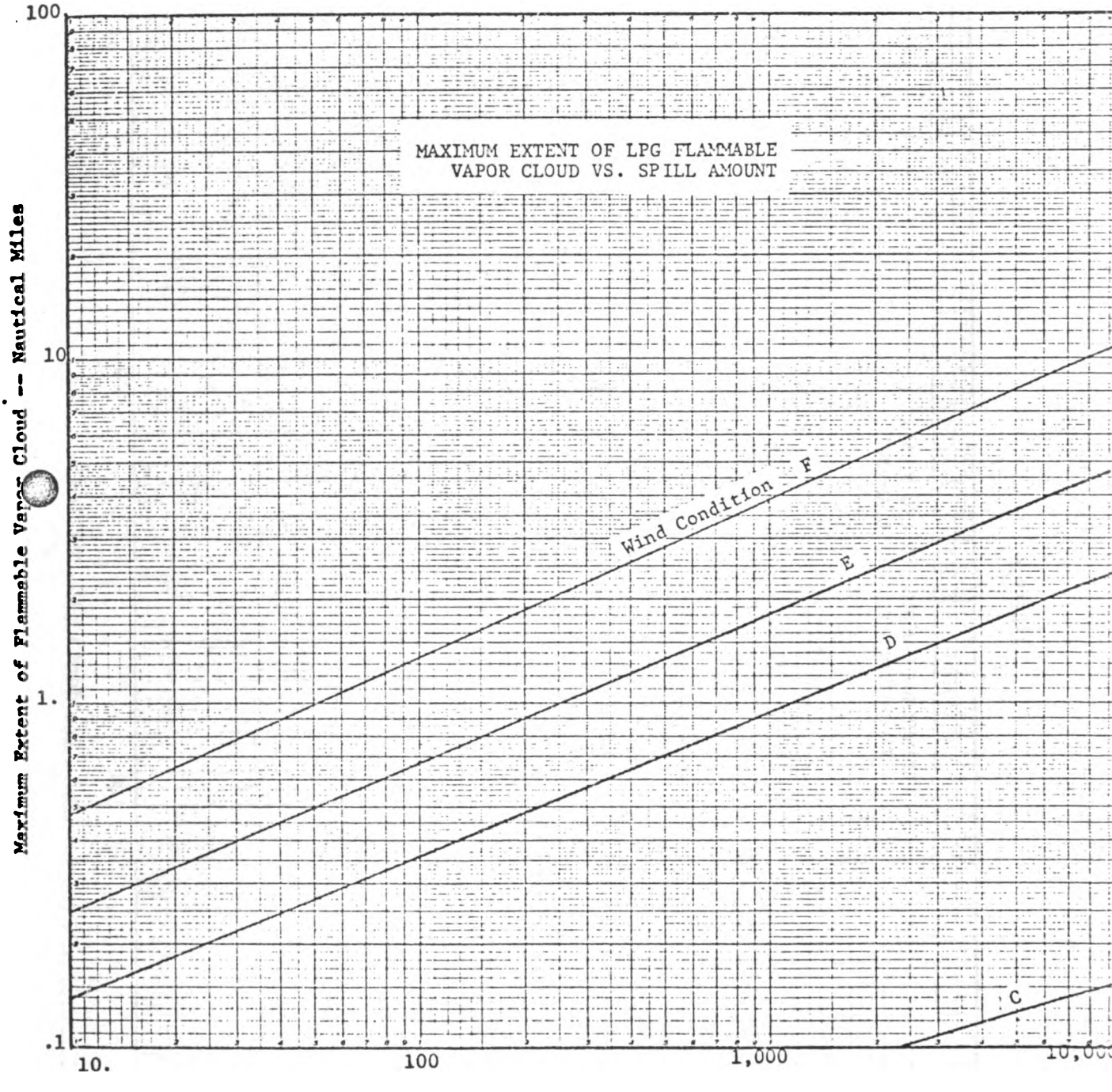

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Figure 4

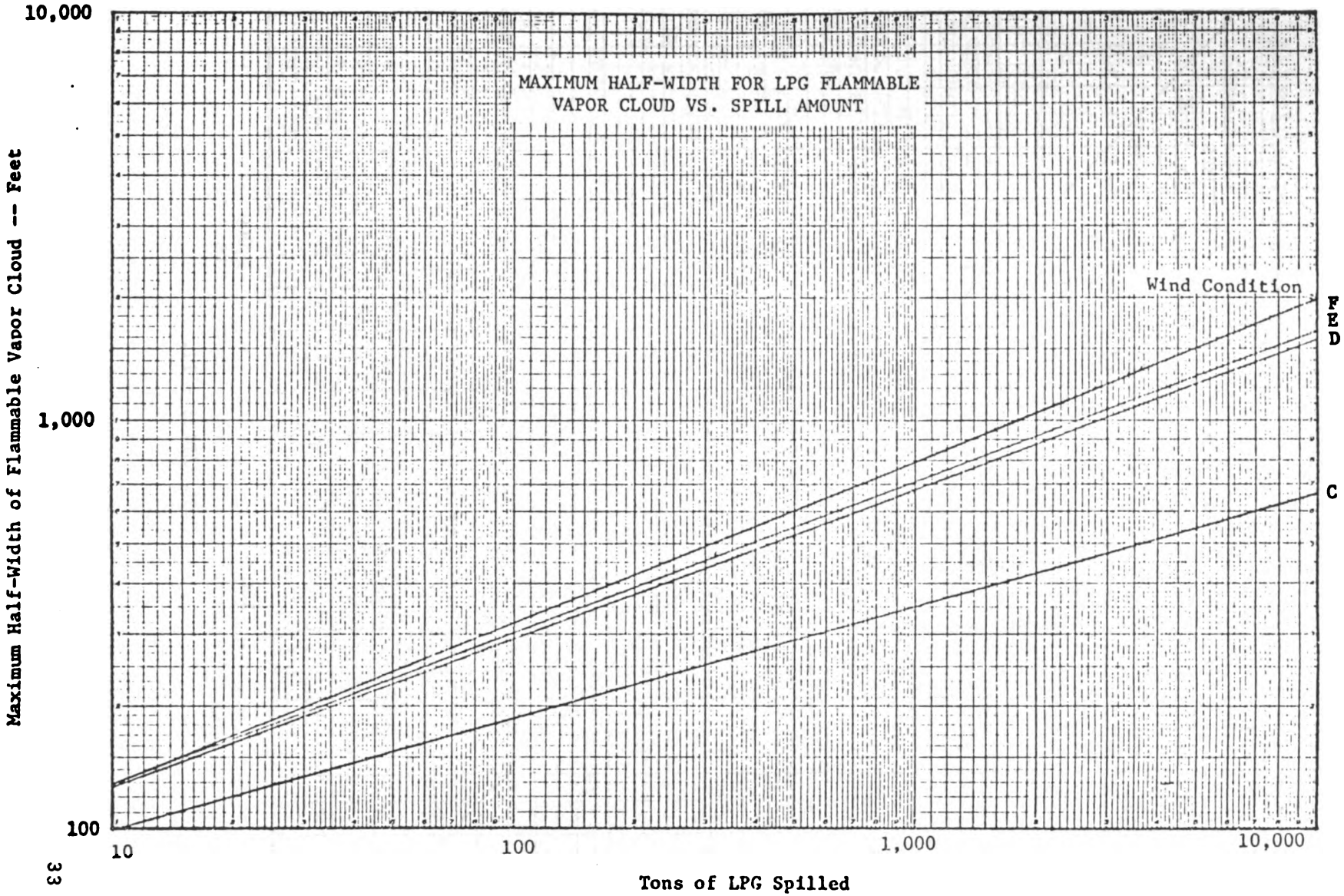

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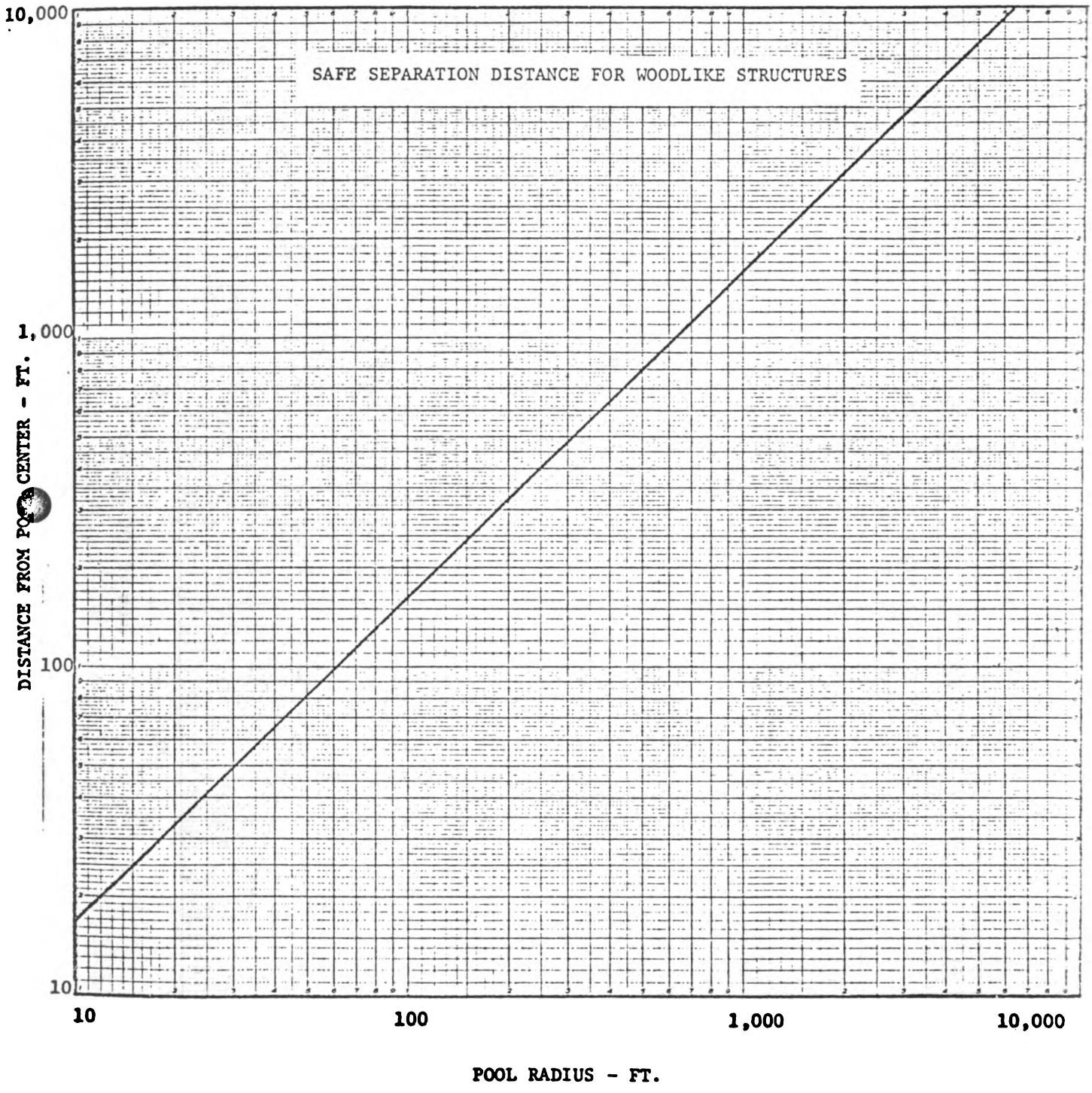
Figure 5



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APPENDIX VII

EMERGENCY PROCEDURES IN THE EVENT OF AN LNG/LPG SPILL

1. Some quick advice:

a. Shut off source.

b. Normally, LNG or LPG fires should not be extinguished until the source can be shut off.

c. In the event of ignition, water should be used to cool down surrounding tanks, piping, equipment and structures. It should also be used to cool down the tank involved in the fire. Water spray can be used to protect personnel involved in shutting down the source.

d. High velocity fog should be used on unignited leaks. This assists in the dispersion of LNG or LPG. It can also direct the vapors away from an ignition source.

e. If possible, personnel should remain upwind of the leak.

f. If it is necessary to remove an LNG/LPG vessel from a facility dock to a safer area within the port, a delay of 30 to 60 minutes for disconnect must be expected.

2. Detailed information on LNG/LPG emergencies procedures:

a. LNG - excerpts from Fire Journal Reprint No. F-J 72-2 entitled "LNG: A Fire Service Appraisal" by Wilbur L. Walls.

"In the form of a spray, water has demonstrated ability to direct flammable vapor-air mixtures through the combined effects of high-velocity drops and air entrained by the drops. In the case of LNG vapors this may have an additional effect by warming the vapors to the point where the natural buoyancy of the LNG vapors can take over and complete the directing away from an ignition source.

Use of hose streams has been investigated to some extent. Used properly, such streams can direct sizable

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"clouds" of LNG vapor. These techniques, furthermore, are very similar to those used for the same purpose in the case of escaping liquid-phase LP-Gas.

The presence of a pool of LNG complicates these tactics, because the vaporization rate of the pool is increased by contact with water, and, of course, the firemen must themselves avoid contact with it. However, this can be surmounted by suitable tactics and by the ability of water to vaporize LNG. At least, unlike gasoline, it need not be flushed into a sewer, to remain a hazard for some time or blow up the sewage treatment plant.

There is obviously a limitation to the size of a flammable mixture controllable by fire department hose streams. In any event, success depends upon the interval between the start of the LNG escape and getting the streams into action. Experience in other fields clearly shows that successful control of this effect in this manner can be expected.

Besides being able to direct flammable mixtures, water may also assist in the control of such mixtures in another way. If converted to a foam and applied to the surface of a pool of LNG, it will float thereon and partially freeze. If the foam is of sufficient depths, the passage of cold vapors through the foam is slowed and the vapors are warmed to the point where they tend to rise upon emergency, rather than to spread horizontally downwind. Experimental work on this appears to have been restricted to high-expansion ratios (around 500:1) seem to be most effective.

Foam has little or no value in controlling such mixtures during the initial leakage period.

Lack of adequate control of the flammable vapor-air mixture is, of course, manifested by fire. Secondary fire control consists of either extinguishing the fire or absorbing heat through application of a suitable agent.

Extinguishment of the fire minimized fire damage, and the shorter the fire, the less is the fire damage. Of the commercially available extinguishing agents, dry chemical, carbon dioxide, and halogenated hydrocarbons can extinguish LNG fires. Air-foam and water will not extinguish LNG fires. Dry chemical, however, has been

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subjected to more testwork and it is the only such agent that hasbeen used in extinguishers and extinguishing systems at LNG facilities. Dry chemical portable extinguishers are invariably supplied and some large fixed systems have been installed. Wheeled units and even truck-mounted hose reels have been provided at large facilities.

In applying an LNG extinguishing agent by means other than a portable extinguisher, certain qualifying conditions should be noted. These agents must do the job quickly or they will not do it at all.

An LNG fire-extinguishing system should be used with caution and in full recognition of its limitations. At best it should be considered as a "fringe benefit" and not relied upon for the sole, or even primary, fire protection for the facility.

The most generally applicable LNG fire control technique, then, utilizes the heat-absorbing capabilities of water. With the exception of ammonia (which has obvious limitations for the purpose under consideration), water has greater heat-absorbing capacity than anything else on earth. It is readily available for days or weeks, if need be, and it is cheap, although the means for applying it may not be cheap.

Aside from the use of water to absorb heat to protect exposed structures, it is the only agent that can be used to protect men while it is performing a function needed to control or extinguish fire. A common such function is the manual closing of a valve to stop the flow of escaping LNG or gas. This tactic has been found necessary at many fires involving flammable liquids and gases and will inevitably be found necessary at LNG facilities. Fire departments know and pratice these tactics.

From the standpoints of secondary control of both the unignited flammable mixture and fire, water appears to be the only practical tool.

In conclusion, experience with actual LNG incidents will probably result in expansion of the principles

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outlined in this article. If this article encourages channeling of control activities into the most realistic approaches, it will have served its purpose."

b. LPG - excerpts from "Liquified Petroleum and Gas Emergencies" by William L. Gessert.

"An LPG spill or large leak is much more serious than one of gasoline of equal quantity. LPG is much more volatile than gasoline. Being more volatile it will produce quickly a much larger vapor cloud that will drift faster and to a greater distance in a shorter time to a source of ignition than will gasoline vapor.

In order for a fireman to understand and appreciate these differences, he must learn about some of the properties of LPG. Discussion of this follows shortly, but first, what are some other important differences?

Normally it is safe to extinguish a gasoline fire, but not so with LPG in most circumstances. In fact the standard rule is not to extinguish an LPG fire unless the fuel supply is shut off first. It is usually safer to let the LPG fire burn out under control because if extinguished and the source of fuel not shut off, a cloud of unburned vapor can accumulate and if re-ignited the flash fire may injure firemen and others in the area. If confined indoors a serious and violent explosion can result.

A burning liquid spill of LPG cannot be extinguished with foam or "light water" as the LPG will evaporate under the blanket, bubble up through it, and burn on top of the blanket. Foam or "light water" will trap gasoline vapor under the blanket and smother the fire.

From a fireman's standpoint the important physical properties are limits of flammability, specific gravity, expansion ratio, and vapor pressure.

(1) Limits of Flammability

The flammable limits of propane are 2.4-9.5% while limits for butane are 1.8-8.4%. These flammability limits are in the general range of gasoline (1.4-7.0%). These percentages are percentage of gas in air.

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(2) Specific Gravity

When LPG is gently released at ground level the vapor does not disperse easily since it is heavier than air. It will flow downhill and downwind, remain close to the ground, and will fill low spots such as ditches and cellars. This does not occur when LPG vapors are discharged from a relief valve as on LPG storage tanks. Due to velocity of discharge and the jet effect and the fact that the discharge is vertical and upward, the vapors will disperse into and quickly mix with the air. A flammable mixture of LPG and air has almost the same specific gravity of air. Under these conditions, vapors may be deflected away from any ignition source by a spray line or a smoke ejector. If a smoke ejector is to be used, it must be explosion proof.

(3) Expansion to Vapor

One gallon of liquid LPG or gasoline when fully vaporized will produce approximately the following volume of pure vapor.

Gasoline	Butane	Propane
200 gallons	230 gallons	270 gallons

A gallon of liquid butane will make about 20 X 230=4600 gallons of a 5% flammable vapor-air mixture. As mentioned earlier, the primary difference between LPG and gasoline is that LPG will flash to vapor quickly while gasoline will vaporize more slowly. Thus gasoline spill will not produce the hazardous vapor cloud as quickly as LPG will.

Remember! This LPG vapor, in a flammable range, has almost the same specific gravity as air (1.0); therefore, it may be dispersed or be deflected from its normal downhill or downwind path.

The primary objective of any activity connected with an LPG emergency is to minimize and avoid hazard to human life. Therefore, the following precautions should be used to guide firemen:

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(a) LPG Emergency without Fire

1 When approaching an LPG leak, approach from upwind and upgrade if possible.

2 When responding to an emergency the order of activity should be to eliminate ignition sources, to survey the area to determine extent of flammable vapor cloud, and to evacuate the area. These three activities should be accomplished simultaneously.

3 All persons except response personnel should be kept 1500 feet from emergency site.

(b) LPG Fire

1 Firemen should be alert to pressure rises in LPG storage vessels that are exposed to fire. A large pressure rise will be indicated by an increase in noise level of the relieving safety valve or the size of the torch fire from the valve. This change in noise and fire volume occurs when the tank is not adequately cooled by hose streams.

2 Extinguishment should be attempted only when shutoff is immediately possible. Flames from a relief valve must not be extinguished. Under any other condition, extinguishment may lead to a vapor cloud, re-ignition, and possible entrapment of fire personnel.

3 All persons except response personnel should be kept 1500 feet from emergency site.

4 In any LPG fire emergency the first priority for cooling must be the vapor space of the shell area enveloped by flame. This portion of the shell will be in the greatest need of cooling as it is here that the "hot spots" will occur. This exposed area may not be very large, but immediately effort should be made to cool this area with long range solid streams from the sides of the vessel.

5 "Sweep" nearby vessels and structures occasionally with hose line. If the water flashes to

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stream on hitting the hot shell, then cooling is needed.

6 Any increase in flame intensity or relief valve noise level will indicate that control of the fire is not being accomplished. Therefore, unless additional cooling is practical through the application of more hose lines or more effective use of the existing hose lines or more effective use of the existing hose streams, immediate withdrawal should be considered.

7 Under any circumstances firemen should take advantage of any cover behind buildings or apparatus that is available. Portable monitors are preferable to hand lines if longer range solid streams can be used. One man should handle the monitor or hose holder and another used to provide an overhead curtain of water spray should the vessel rupture and produce an overhead fire ball. All other personnel should retreat to a safe area.

(c) LPG Leak Control

1 Hose lines adjusted to driving water spray is effective in dispersing LPG vapor. It should be used immediately, directing the spray stream across the normal vapor path. Conditions permitting and when the leak cannot be stopped, ignition may be advisable with controlled burning so long as the vessel and piping may be cooled. Intentional ignition of a vapor cloud may be risky. It must be sized up carefully to avoid injuries. In some instances where there is leakage from an LPG truck or trailer without a fire, it may be desireable to move the equipment to some remote area.

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APPENDIX VIII

GLOSSARY OF TERMS

CHRIS - Chemical Hazards Response Information System (CG)
COTP - Captain of the Port (CG)
DPS - Department of Public Safety (State of Mass.)
DPU - Department of Public Utilities (State of Mass.)
ETA - Estimated Time of Arrival
ETD - Estimated Time of departure
LNG - Liquidfied Natural Gas
LPG - Liquified petroleum Gas
MASSPORT - Massachusetts Port Authority
MIO - Marine Inspection Office (CG)
OCMI - Officer in Charge of Marine Inspection (CG)
OOD - Officer of the Day (CG)
OSC - On Scene Co-ordinator
PSSTA BSN - Port Safety Station Boston (CG)
RCC - Rescue Co-ordination Center (CG)
SNG - Synthetic Natural Gas
USCG - United States Coast Guard

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